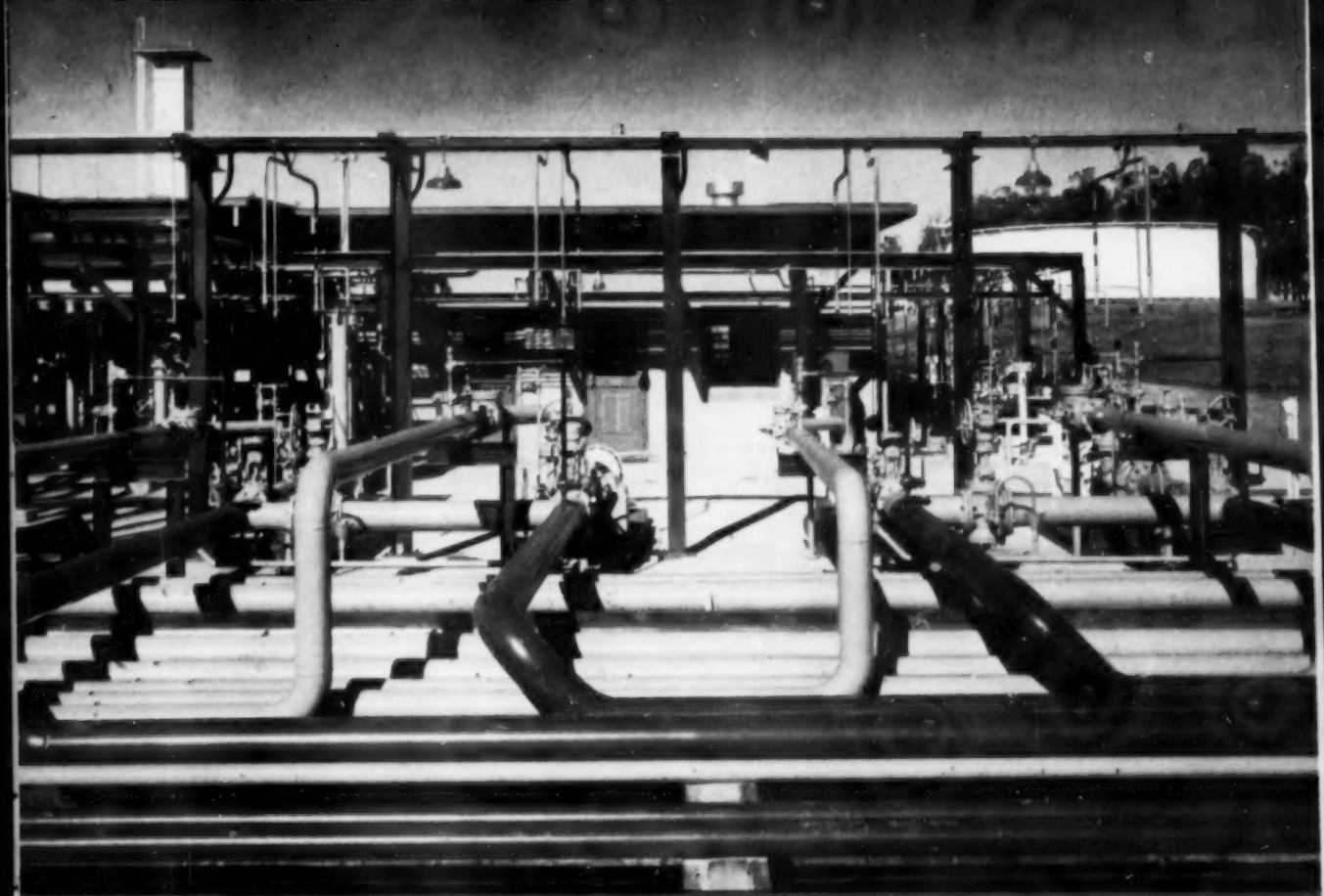
Petroleum Processing

PETROLEUM REFINING | PETROCHEMICAL MANUFACTURING | GAS LIQUIDS RECOVERY

APRIL, 1956



MOTOR FUEL BLENDING—Which is the best method today? p. 82

PRODUCT QUALITY—How chemical treating will improve it . . . . . p. 45

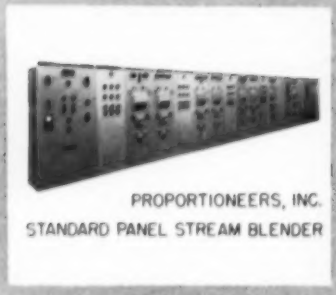
TRAY DESIGN BASICS—Part 3 in a new design manual for you . . . p. 72

HOW 'BAD' CAN RAILROAD DIESEL FUELS BECOME? . . . . . p. 81

PRICE 35 CENTS A McGRAW-HILL PUBLICATION

TECHNICAL DATA

Shell Products Pipe Line was one of the first to recognize the flexibility of operation made possible by continuous automatic "stream" blending. This company has installed B-I-F Industries' equipment at their Wood River Pump Station for blending finished gasolines directly to their North and East lines respectively. Preset formulations at all flow rates of finished product demanded by the pipeline are automatically maintained by multiple component blenders . . . to blend six gasoline base stocks, T.E.L., dye, and gasoline additives to pipe lines without intermediate tankage. Full particulars on this installation are available



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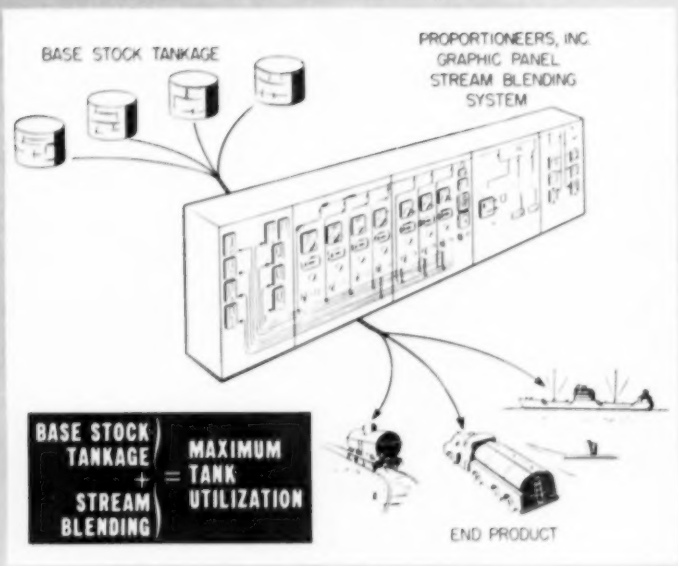

THE PROBLEM

As automobile manufacturers continue their current trend toward higher-compression engines, refiners face an ever increasing demand for premium motor fuels. New processes, or improvements on existing processes, are being installed to meet these demands. The fuel outlook is further complicated by the fact that the automotive industry is developing engines requiring lower grade fuels . . . and predictions indicate these engines will be in use by 1960.

THE SOLUTION

The fast growing petroleum industry is quick to recognize and adopt equipment which facilitates product movement . . . and continuous automatic blending gives refinery operation the flexibility it needs to keep pace with progress. Stream blending not only provides tailor-made hydrocarbons, but minimizes the need for intermediate tankage and allows specific seasonal market conditions to be met without costly inventory change-overs. B-I-F Industries, Inc. is the leading manufacturer of this type of equipment . . . and boasts the greatest number of diversified installations.

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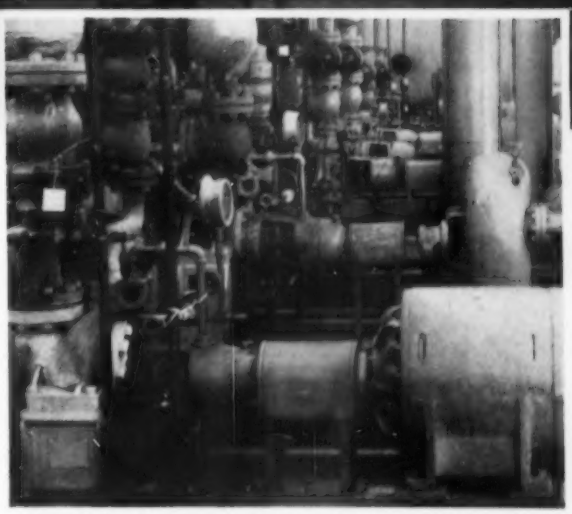

A few of the 20 Wilson-Snyder Type ES Centrifugal Process Pumps which handle the various combinations of capacities, differential heads, specific gravities and temperatures involved in this installation. Wide interchangeability of parts results in minimum inventory requirements.

NEW CONSTRUCTION involves problems of procurement and expediting, as well as design and erection. But American Liberty Oil Company, Mt. Pleasant, Texas, avoided all this when they modernized their 5,000 b/d thermal cracking facilities and added a new 6,000 b/d catalytic cracking unit.

How? By selecting "Oilwell" to procure the materials and equipment involved in the construction of this project . . . thus centralizing all the details in one reliable source.

IF YOU . . . are about to undertake a construction project, bring your procurement and supply problems to "Oilwell." Learn for yourself the many advantages of shifting logistic responsibilities to a long-established, fully-integrated organization that specializes in supplying the Petroleum Industry.

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Reader's Guide

What's New in Petroleum

A SPECIAL SYMPOSIUM

How to Improve Product Quality By Chemical Treatment

A big problem today is how to get more products of high quality out of each barrel of crude oil — how can stocks obtained by normal process methods be further upgraded?

Chemical treatment has attained considerable stature as one of the processors' trump cards for getting this quality. Up to now, however, little up-to-date information has been published on the subject.

In this four-article symposium, you will find a wealth of helpful information on chemical treatment.

1. HYDROGEN TREATING of crudes and heavier-than-gasoline stocks, by Jerry McAfee and W. A. Horner **p. 47**
2. CHEMICAL AND HYDROGEN TREATING of petroleum fuels heavier than gasoline, by W. W. Scheumann. **p. 53**
3. MERCAPTAN REMOVAL AND CONVERSION in gasoline and its components, by H. E. Walker and E. B. Kennelly **p. 58**
4. PRESSURE-HYDROGEN TREATING of petroleum naphthas, by Marshall Sittig **p. 67**

"Powerforming" Makes It 14

Latest addition to the roster of catalytic reforming processes is "Powerforming," Esso Research & Engrg. Co.'s new fixed-bed, cyclic process using a platinum type catalyst and a newly developed regeneration technique. **p. 69**

Soyez les Bienvenus a Montreal

. . . which means "Welcome to Montreal." If you're one of several thousand who will attend the Mid-Year Meeting, API Division of Refining in May, here is a concise rundown on what to do and see in this beautiful Canadian city. **p. 70**

Bubble-Cap Tray Design — Part III

In this month's installment, design techniques are developed to make possible an optimum tray design for any specific design, using the tools of *tray dynamics* and *design standards* developed in Parts I and II, from the February and March issues.

This first truly complete manual of new process design methods for optimum bubble-cap tray design was prepared exclusively for the readers of this magazine by William L. Bolles, of Monsanto Chemical Co. **p. 72**

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Processing for April, 1956

PETROLEUM REFINING | PETROCHEMICAL MANUFACTURING | GAS LIQUIDS RECOVERY | RESEARCH & DEVELOPMENT | DESIGN & ENGINEERING | PLANT OPERATION | MAINTENANCE & CONSTRUCTION | MANAGEMENT & PERSONNEL

I II III 1 2 3 4 5

Earthmoving — Quick and Easy

How Sun Oil Co. at its Marcus Hook, Pa., refinery, is solving several troublesome earthmoving problems with digging machines, particularly in spots where working space is extremely limited. A story in words and pictures. **p. 80**

I II III 4

How "Bad" Can Diesel Fuel Be?

Railroads do not need high quality diesel fuel, says this report on a 10-year study by the Coordinating Research Council. Distillate supply-demand in the future may force the roads to widen their useable fuel range as much as possible. **p. 81**

I 1 3 5

Which Blending Method Is Best?

With a multitude of materials to blend into another multitude of finished motor fuel products, which method should a refiner use? – batch, partial on-stream, or continuous automatic on-stream blending?

Each technique has its advantages and disadvantages. Here is a complete review of the various methods that are available to the processor today. Although it is a story of gasoline blending, it will be of help in solving problems of blending other products as well. By B. Gardner Crane **p. 82**

I 2 3 4

AND IN THE FUTURE

More Information-Packed Issues

It will pay you to keep your eyes peeled for your copy of PETROLEUM PROCESSING every month.

Coming your way in the near future – some next month, others farther down the line – are articles on these subjects:

- Six Tough Turnaround Problems and How They Were Licked.
- Adipic Acid – Its Uses and How It is Made via the Cyclohexane Route.
- The fourth and final installment in the series of articles on Bubble-Cap Tray Design.

Significant Ideas for Tomorrow

. . . as seen by the editors. Subjects this issue in this regular monthly department include: plastic pipe and its potential; the future for heating oil quality; and other process application for radiation; and a new thought on computers. **p. 15**

I II III 1 2 3 4 5

Getting All You Have Coming?

Our new Readers' Service Card has been redesigned for your convenience. If you need or want extra copies of some of our popular reprints or our new Data Sheets, use this handy card. It's an easy and fast way to get what you want. **p. 143**

I II III 1 2 3 4 5

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Continue "Readers' Guide" on p. 93

HOW TO USE IT:

Your new "Reader's Guide to What's New in PETROLEUM PROCESSING" will do two things for you. First, the key numbers with each article will tell you at a glance if it is within your scope of interest; Roman Numerals indicate industries; Arabic Numerals, fields of activity. Second, the longer descriptions will tell you what each article is about, and why it can be of help and interest to you. —THE EDITORS

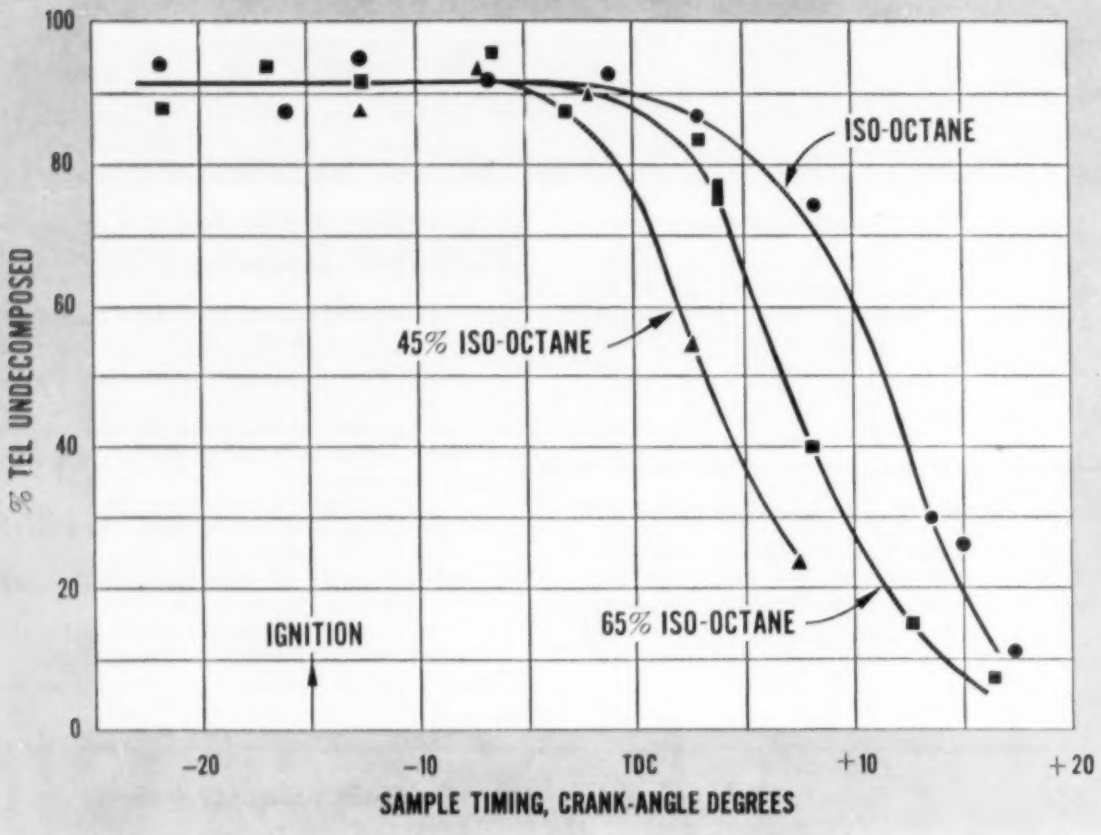


Fig. 1. TEL decomposition in fired engine. Fuels: mixtures of iso-octane and n-heptane containing 6 ml TEL per gallon.

New research on antiknock action

by ***ELLIS B. RIFKIN***
Ethyl Corporation, Detroit, Mich.

Although tetraethyllead is widely used as an antiknock agent, some fundamentals of its action are still not completely understood. Since a full understanding of the mechanism of its action could presumably lead to increased effectiveness of utilization—the Ethyl Corporation conducts a continuing basic research program on antiknocks.

Many theories concerning the mechanism by which tetraethyllead acts as an antiknock in the internal combustion engine involve either the process by which tetraethyllead decomposes or the products resulting from such decomposition.

This report describes the studies of variables affecting the decomposition of tetraethyllead both in fired engines and in motored engines.

In a first series of experiments, a spark-ignited, fixed-compression ratio, L-head engine was employed. This engine was equipped with a sampling valve of special design which permits repetitive extraction of small samples from the end-gas region of the combustion chamber.

Mixtures of iso-octane and normal heptane were used as fuels, and end-gas samples were taken at 5° intervals from 25° before top center to 20° after top center. The results of these studies are indicated in Figure 1 which shows:

1. That essentially all the tetraethyllead is decomposed before the mixture is consumed by the flame front.

2. That the rate of tetraethyllead decomposition is markedly affected by fuel composition.

In order to resolve this effect of fuel composition more completely, it was decided to conduct a second series of experiments—this time in a motored engine, to permit measurement of temperatures. A single-cylinder engine was again used, but in this series of experiments, the engine was of the variable-compression ratio type to permit variation of temperature and pressure of the fuel-air mixture over as wide a range as possible.

Mixtures of iso-octane and normal heptane as well as di-isobutylene were the fuels tested. Figure 2 illustrates the effect of fuel composition on tet-

(To obtain more data on advertised products see page 142)

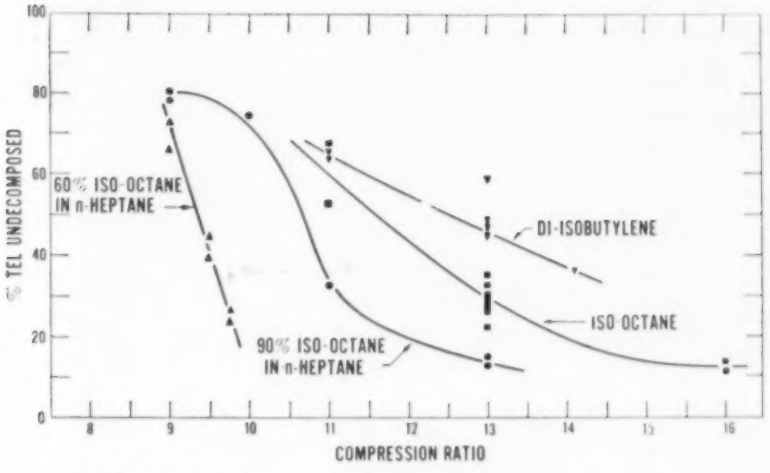


Fig. 2. Effect of fuel on TEL decomposition in a motored engine.

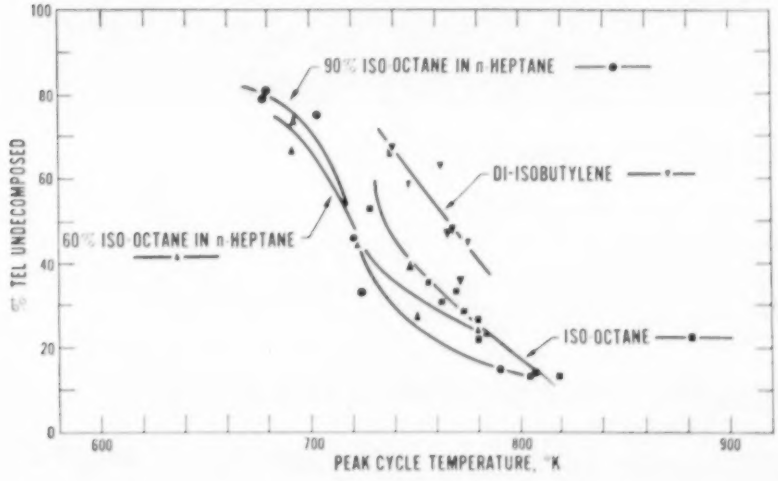
raethyllead decomposition in the motored engine—somewhat comparable data to that shown in Figure 1 for the fired-engine studies.

Again, an apparent correlation was obtained between fuel composition and rate of tetraethyllead decomposition—with the more rapid rates being associated with fuels of higher octane number.

To gain still greater insight into this relationship, technicians calculated peak cycle temperatures and the tetraethyllead decomposition data were examined against this variable. The results of this work are shown in Figure 3. It can be seen immediately that most of the variation due to fuel composition has been eliminated. This leads to the conclusion that temperature may be the one basic variable governing the decomposition of tetraethyllead—and that fuel composition has only an indirect influence so far as it affects the peak temperature of the charge in the cylinder. A mathematical analysis taking into account the variation in temperature of the charge throughout the cycle and comparison of those data with tetraethyllead decomposition data confirm this conclusion.

This account of one typical research project in the Ethyl Laboratories is designed to give you in the petroleum industry a glimpse into the vast body of continuing research being carried out to guarantee the maximum effectiveness of "Ethyl" Antiknock Compound.

Fig. 3. TEL decomposition in four fuels related to peak cycle temperature.



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Ethyl Research is in the unusual position of being able to serve both the petroleum and automotive industries.

In that capacity, we have contributed much in the field of fundamental as well as applied research. Today at our laboratories in Detroit we are conducting studies on the nature of combustion . . . the cause of preignition . . . and the mechanism of deposit accumulation.

Searching for answers to these "basic" problems has led us to develop many new instruments and new techniques. The information which we have developed from our research efforts is being constantly circulated throughout both the automotive and petroleum industries to help the different companies with their research.

If you desire any information concerning fuel-engine problems, just contact your Ethyl Laboratory Technical Representative.

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Publisher's Page

Just Call Us "V.I.S.'s"

ONE question I am frequently asked by readers is this: "Just what does an editor on a publication such as PETROLEUM PROCESSING do; what is his job?"

And that isn't quite as easy to explain as you might think. It's simple enough to describe the job of a draftsman or a project engineer. But not so with a technical editor; he's a rather peculiar breed of engineer.

For one thing, he isn't really a technical writer, even though he is often referred to as such. Words are one of his tools, of course, but he spends only a very little of his time stringing them together to form sentences and paragraphs, to make a story.

He spends a lot more of his time out in the field, gathering facts—not as a newspaper reporter looking for a hot "scoop" but rather to get the "feel" of our industry. He goes to meetings, attends demonstrations, visits plants. Sometimes he isn't even working on a story; he may be more interested simply in talking with you readers—to find out what you're thinking about, what you're doing, what your problems are—so he'll have a better idea of what he should be looking for that'll be helpful to you.

(In that connection, I've just finished a study of our 1955 travelling. Last year, PETROLEUM PROCESSING's full-time editors took 55 separate trips, visited 108 plants or offices, and covered over 70,000 miles doing it. And that doesn't include the "local" calls made here in New York, or by our field editors.)

He also spends a lot of his time "handling" what other people have written for us—rewriting it, organizing it, simplifying it. He puts a lot of thought into figuring out how to present an article to you, so you'll get the most out of it in the quickest possible time and with the least amount of effort on your part. He does that with illustrations—photographs, charts, drawings. He does it with headlines, and with prominent bold face words or subheadings at pertinent spots in the story. He does it by yanking out some of the supplementary material and putting it off to one side as "optional" reading—something you can read if you want to and have the time, but which isn't absolutely essential to the story.

In short, an editor on PETROLEUM PROCESSING knows how to recognize and gather helpful facts, how to organize and explain them in clear English, and finally how to get the story across to you. He's a "V.I.S."—a "Visual Information Specialist!"

William F. Bland

—Editor

P.S.—Sometime soon I'll give you a "case history" on how a typical story is originated and put together.

Other McGraw-Hill Petroleum Publications

National Petroleum News
The monthly magazine of oil marketing—news, prices, transportation, storage merchandising

Platt's Oilgram News Service
A daily independent oil-news reporting service issued from New York, Chicago, Houston

Platt's Oilgram Price Service
A daily independent oil-price reporting service issued from New York, Chicago, Houston

Petroleum Week
The industry-wide magazine—covering production, processing, transportation, marketing

it pays to plan with General American

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Some liquids need to be "terminalled" in tanks of aluminum—some in stainless steel. Some must be kept warm with heating coils—some require refrigeration. Special valves and pumps must be designed to handle many of these liquids. Above all, you need the knowledge and experience of experts, especially for "ticklish" chemicals. General American has both facilities and personnel—available to you on an advantageous lease basis.

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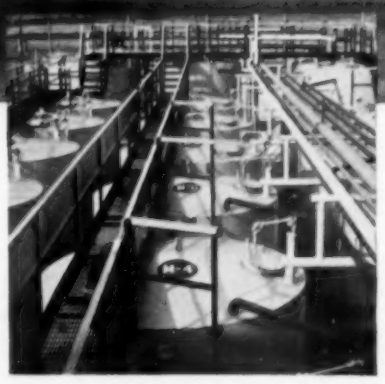

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What's Happening...

in Refining

. . . **Gulf Oil Corp.** is spending about $18-million on expansion at Philadelphia. New process units, the contractors, and schedules for completion are:

A 26,000 b/d Platformer, UOP design, Procon construction, mid-1957. A 3000 b/d sulfuric acid alkylation unit, Ralph M. Parsons construction, spring or summer of 1957. Two "Gulfining" units (heating oil desulfurization), 20,000 b/d each, M. W. Kellogg, early 1957. A 22,500 b/d visbreaker, Catalytic Construction, this month.

. . . **Pacific Petroleum Ltd.** plans an $18-million gas processing plant in the Peace River area of Canada, to handle 300-million cfd of natural gas, turn out 1700 b/d natural gasoline, 500 b/d diesel oil, 300 b/d propane, and 600 b/d of butane.

. . . **British American Oil Co.** says it will double the 21,500 b/d capacity at Clarkson, Ont.

. . . **Standard Oil Co. (Ohio)** has announced its proposed $30-35-million expansion will be for 100,000 b/d new capacity at Toledo, Ohio.

. . . **Atlantic Refining Co.** expects to award contract soon for two 15,000 b/d Catforming units; one at Philadelphia, the other at Atreco, Tex.

. . . **Standard Oil Co. (N.J.)** affiliates in U.S. and abroad will invest an estimated $60-million in 16 catalytic reformers using Esso Research & Engrg. Co.'s new "Powerforming" process. [What's Happening, March, 1956, p. 9, also p. 69, this issue].

. . . **Shell Oil Co.** has awarded Arthur G. McKee Co. construction contract for a second UOP Platformer at Wood River, Ill., with capacity of 20,000 b/d.

. . . **General Petroleum Corp.** will spend about $9-million at Ferndale, Wash. Largest project is 9000 b/d Sovaformer, to be finished in 1957.

. . . **Ohio Oil Co.** president J. C. Donnell II has said his company has "under study the opportunities for further expansion of refining and marketing."

. . . **Tide Water Associated Oil Co.** plans further refining expansion beyond current programs on East and West Coasts; will issue $100-million, 30-year sinking fund debentures to finance it.

. . . **Cities Service Oil Co.** will operate a natural gasoline plant to be completed early in 1957 near Midland, Tex., with 50-million cfd capacity.

. . . **New construction projects** as indicated by recently approved fast tax write-offs:

Onyx Refining Co., $123,000, for refining facilities at Abilene, Tex.

Cities Service Refining Corp., $154,000 for facilities at Lake Charles, La.

Continental Oil Co., $1,607,649 on gasoline plant and gathering lines, Washington City, Colo.

in Petrochemicals

. . . **Kopper Co.** and polyethylene expansions were in last month's news in three areas.

In Los Angeles county, north of Wilmington, Calif., as joint venture with Brea Chemicals, Inc., $10-million will be spent on two units: an ethylene plant to operate on gas from Union Oil's Los Angeles refinery, and a low-pressure (Ziegler) polyethylene plant with ultimate capacity of 60-million lb/yr. Brea will operate the plant. Koppers' engrg. and construction division will build the poly units. The ethylene unit construction contract will be let soon. Mid-1957 is target for completion.

In Woodbridge, N.J., a "multi-million dollar", 30-million lb/yr Ziegler polyethylene plant will be completed in mid-1957, to operate on ethylene from Esso's new unit abuilding at Linden, N.J.

At Port Arthur, Tex., 18-million lb/yr of new capacity has gone onstream for Koppers.

. . . **Petroleum Chemicals, Inc.** will complete in the fall of 1957 a $12.5-million, 100,000 ton/yr. anhydrous ammonia plant at Lake Charles, La., to operate on by-product hydrogen from Cities Service and Continental Oil refineries nearby.

Petroleum Chemicals has awarded contract for its 16,000 ton/yr butadiene expansion [What's Happening, Feb., 1956] to Fluor Corp.

. . . **Marbon Chemical Div.** Borg-Warner Corp. has awarded Catalytic Construction Co. a $10-million contract for a high-styrene type resins plant at Washington, W.Va., with completion early in 1957.

. . . **Shell Chemical Corp.** will complete early in 1957 a 40-million lb/yr methyl ethyl ketone plant at Norco, La.

. . . **Commercial Solvents Corp.** will spend major part of $10-million in expansion of methanol and derivatives facilities at Sterlington, La.

. . . **Mobay Chemical Co.** plans to triple capacity of its newly completed New Martinsville, W.Va., isocyanates and polyesters plant as soon as possible. Blaw-Knox Co. has construction contract. Completion will depend on availability of materials.

. . . **General Aniline & Film Corp.** will spend about $8-million on a new ethylene oxide and ethylene glycol plant at Linden, N.J., to operate on ethylene from Esso. Completion is scheduled for 1957, oxide capacity will be 60-million lb/yr. Scientific Design Co., Inc., has design and engineering contract.

. . . **Warren Petroleum Corp.** has purchased 300 acres in Houston for a multi-million-dollar petro-chemical project. No further details have been disclosed.

. . . **Texas Eastman Co.** will complete an expansion at Longview, Texas, this year in polyethylene, to up capacity to 40-million lb/yr.

. . . **Phillips Chemical Co.** will build a new 64-million lb/yr carbon black plant on Gulf Coast.

. . . **Continental Oil Co.** is moving further into the petroleum sulfonates business with the acquisition of Sherwood Refining Co., who operate two plants (in Gretna, La. and Karns City, Pa.).

. . . **W. R. Grace & Co.** has decided to build its $18-million, 50-million lb/yr polyethylene plant at Baton Rouge, La. with completion by mid-1957. Fluor Corp. has construction contract.

. . . **Escambia Bay Chemical Corp.** plans other petrochemicals besides ammonia at Pensacola, Fla., including a $4-million, 30-million lb/yr polyvinyl chloride unit.

. . . **Firestone Tire & Rubber Co.** will start in May a 40,000 ton/yr butadiene plant on a 1000-acre site at Orange, Texas. Catalytic Construction Co. has contract.

. . . **Pitt-Consol Chemical Co.** has begun construction of a plant to make cresylic acid from petroleum feedstocks at Newark, N.J. Completion is expected in October. Unit will also use as raw materials liquids to be produced from coal by company's new carbonization process.

. . . **Hercules Powder Co.** will build a new $2-million, 7-million gal./yr. methanol unit at Louisiana, Mo., part of its pentaerythritol production.

. . . **Shell Oil Co. of Canada, Ltd.,** is adding facilities at Montreal East, Que., to manufacture methyl ethyl ketone and secondary butyl alcohol, to operate on butylene from Shell's refinery.

. . . **Goodrich-Gulf Chemicals, Inc.** is starting a four-year modernization and expansion project at the Institute, W.Va., synthetic rubber plant it is buying from the government. About $2-million will be spent in 1956, and overall program has been estimated at $6-million.

. . . **Dow Chemical Co.** is planning major expansions in Louisiana and Texas requiring an estimated $20-million during next few years. It has taken options on three sites along the Mississippi in the Baton Rouge-Plaquemine area.

In addition, a $45-million program for Freeport, Texas, was announced. New units will be built for acetylene, methyl acetylene, ethanolamines, synthetic glycerine, and soil fumigants. Expansions include butadiene, ethylene oxide, methyl chloroform, synthetic glycerine, glycol, perchlorethylene, styrene, chlorine. Total project will take about 18 months, with completion planned for first half of 1958.

. . . **Hidalgo Chemical Co.** was scheduled to start operating the Brownsville, Texas, plant this month. Natural gas requirements ultimately are expected to reach 90-million cfd.

. . . **Canadian Oil Co.** is building a $4-million sulfur recovery plant in the Pincher Creek, Alta., field, with an initial capacity of 225 ton/day.

. . . **Neches Butane Products Co.** plans a $16-million plant expansion at Port Neches, Texas.

. . . **Diamond Alkali Co.** will double present capacity for perchloroethylene at Houston, Texas, with completion scheduled for January, 1957. Program also includes new ethylene dichloride facilities.

. . . **Richfield Oil Corp.** has awarded Macco Corp. contract for $500,000 unit at Wilmington, Calif., to raise hydrogen sulfide (and sulfur) recovery.

. . . **Phillips Petroleum Co.** has taken an option to buy a 950-acre site on Houston Ship Channel for a reported price of about $3-million.

Aim is to promote a huge chemical center, which may eventually represent a $100-million investment and provide customers for Phillips' natural gas or related materials. Celanese is reported interested in building a polyethylene plant on the site. Phillips plans no facilities of its own.

. . . **Heyden Chemical Corp.** will complete a new 25-million lb/yr. pentaerythritol plant at Heyden Fords, N.J., in March, 1957.

in Foreign Operations

. . . in the satellite countries:

The Hungarian refinery at Szoeny is building a $16,950,000 cracking unit, with completion scheduled for 1958.

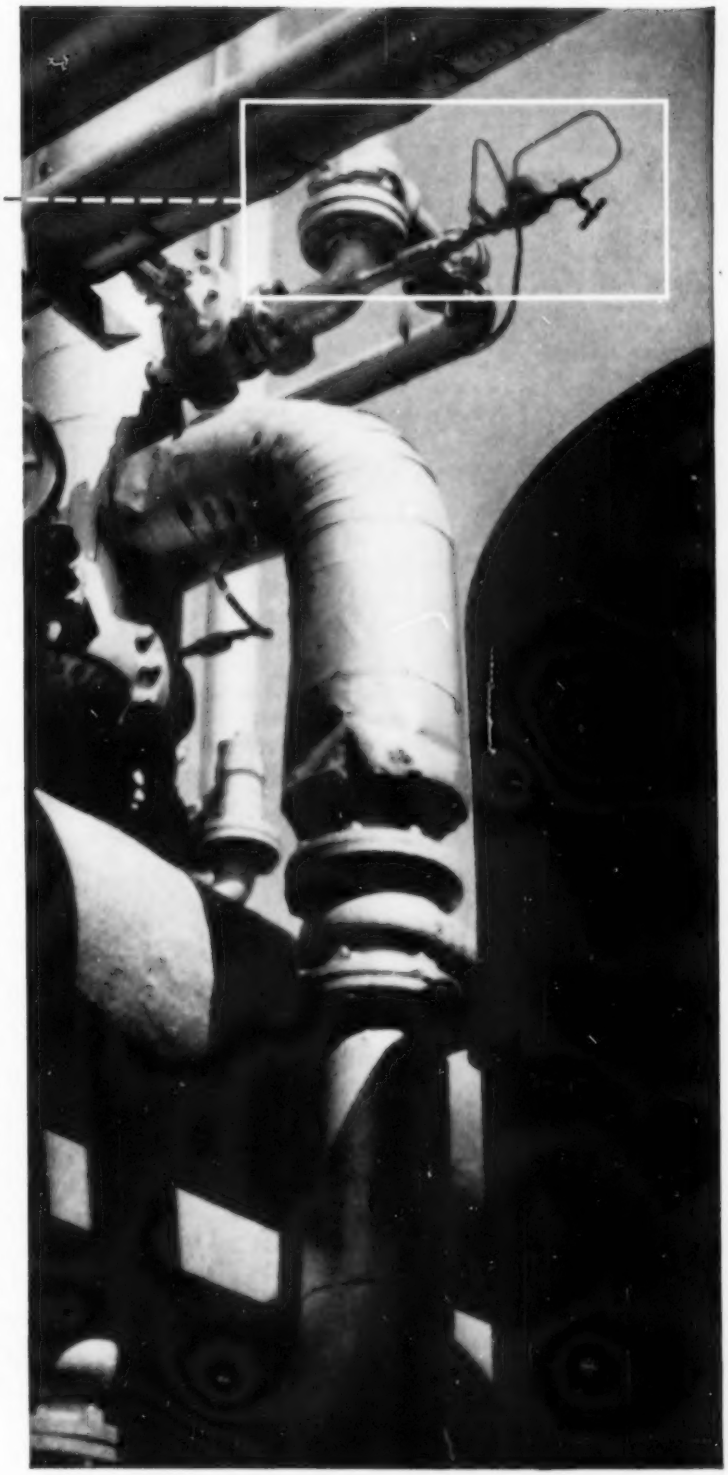
The capacity of Poland's Podkarpacie refinery (exact site and actual size not disclosed) was doubled in December when a new two-stage crude still went on-stream.

. . . in Latin America:

Petroleos Mexicanos plans to build in the Bayo area of Tabasco state, on about 700 acres, "Pemex City", a self-sufficient installation including a refinery, gas absorption plant, offices, homes.

At Cubatao, Brazil, Alba S.A. (a Borden Co. interest) is starting a $3.5-million expansion that will give Brazil its first methanol unit and increase production of formaldehyde and synthetic resins. Completion is

LIFELINE FOR A REFINERY



This thin loop of copper tubing is the mark of a refinery that has learned to combat corrosion and fouling the modern Polyrad way. This is the injection line for Polyrad—and it can well be called the "lifeline" for refinery equipment.

Polyrad is a filming amine that acts both as an inhibitor and detergent. Its detergency maintains throughput, increases heat transfer, and cuts down time for maintenance. At turn-around time you really see the difference—Polyrad—protected bundles are free of corrosion, ready for immediate return to service.

Stocks of Polyrad are maintained throughout the country. A Hercules trained representative will be glad to discuss its application to your specific operating conditions.

Pine Chemicals Division, Naval Stores Department
HERCULES POWDER COMPANY
984 King Street, Wilmington 99, Del.

POLYRAD®
FILMING AMINE INHIBITOR

NASS-6

slated for 1958: methanol capacity will be 30 tons/day.

Esso Standard is expanding its Havana, Cuba, refinery from 8000 to 14,500 b/d.

First petrochemical plant formed in Peru for making nitrogenous fertilizers, Fertilizantes Sintéticos S.A., has been organized. A $7-million, 18,000 metric ton/yr amomnia plant (Montecatini process) will start operations at the end of 1957. Location not disclosed.

. . . in the East:

First oil-from-coal plant in India, a 300,000 ton/yr unit, is slated to start building in 1957, in East Raniganj coal area. (Another oil-from-coal plant is being considered by British interests in Lubimbi coal region of Rhodesia, central Africa).

Iraq government plans to expand existing three refineries—at Baghdad, Khanaqin, and Basrah—sufficiently to meet all domestic petroleum demands.

Indian government hopes to form new company as a joint venture with Assam Oil Co., to explore for new crude, produce it, and build new 21,000 b/d refinery at Calcutta, at cost for plant of $70-million.

Soviet Russia has been pushing Lebanon government with readiness to build new refineries, offering technical aid and equipment.

. . . in Britain and Europe:

Esso, Caltex, and Shell may form a new company to build a refinery at Whitegate, Ireland. Options have been taken on a 1300-acre site.

Esso also figures in two other new plants. Esso AG of Hamburg will build a $176-million, estimated 75,000 b/d refinery at Cologne: and Esso Standard SAF plans a 30,000 to 40,000 b/d refinery near Bordeaux, France.

Raffinerie Belge de Petroles has awarded Kellogg International contract for a combined desulfurizer and catalytic reformer at Antwerp.

Imperial Chemical Industries Ltd. is building a $5-million polyethylene plant at Botany, Australia, with completion scheduled near end of 1957.

in Markets and Prices

. . . An increase in product prices on West Coast, resulting from the 6% industry wage increase pattern set throughout the U.S. highlighted March developments. Suppliers advanced distillate fuels and gasoline 0.2¢/gal. Heavy fuel prices generally were raised 5¢/bbl.

Mild weather in late February and early March toned down earlier strong demand for heating fuels in major consuming areas, but primary prices generally held unchanged.

. . . Meanwhile, the big push is on for gasoline. At the Gulf, buying interest picked up. Major refiners, especially in the East, were apparently little concerned over record stocks hit in March.

In the Mid-Continent, refiners upped octanes on gasoline tendered to Great Lakes Pipe Line by two numbers—to 96 for premium and to 88 for regular.

Major gasoline price development included increases ranging from 0.25 to 0.75¢/gal in most Texas refinery districts, and 0.25¢/gal at Chicago. In the troubled New England market, Socony raised depressed "net" dealer tank wagon prices as much as 3.15¢/gal.

. . . Lube oil prices in Mid-Continent went up 1¢/gal., with 200-210 vis. solvent neutral quoted at 19.75¢ and solvent refined bright stick at 24¢/gal.

. . . In Pennsylvania, refiners got second crude boost since first of year. South Penn Oil advanced its postings 20¢/bbl. for all Penn-grade crudes the middle of March. Bradford district oil is now $4.20/bbl. Supplies of all base lube oil stocks were tight before the crude increase, and higher prices were anticipated by the trade generally.

Natural gasoline prices were trimmed 0.5¢/gal. in the Mid-Continent. Grade 26-70 was quoted at 5¢. Group 3, and 4.5¢, Breckenridge.

Looking Ahead

. . . Proved U.S. reserves went up another notch in 1955 in spite of record-breaking production and consumption, according to annual report by API and American Gas Association. Total liquid hydrocarbons now are over 35-trillion bbl.; total gas is over 223-trillion cu. ft.

As summarized below: liquids increase was 1.85% as against production rise of 7.1%. Gas reserves rose 5.7% as against production rise of 7.4%.

Reserves (millions of bbls. & billions cu. ft.)

	12-31-54	12-31-55	Increase vol.	Increase %age
Crude oil	29,561	30,012	451	1.5
Nat. gas liqs.	5,244	5,439	195	3.7
total liqs.	34,805	35,451	646	1.85
Natural gas	211,711	223,697	11,986	5.7

Production (millions of bbls. & billions of cu. ft.)

Crude oil	2,257	2,419	162	7.2
Nat. gas liqs.	301	320	19	6.5
total liqs.	2,558	2,739	181	7.1
Natural gas	9,426	10,118	692	7.4

. . . Less gasoline blending in the plant? It's an extremely long shot now, but if Sun Oil's marketing experiment in Florida succeeds, it's a possibility. Sun is selling five grades of fuel from one pump. How? By automatic blending at the pump, controlled quantities of high octane blend agent with good base stock. (See Editorial pg. 176.)

. . . Rubber in asphalt for highways? Yes, say officials of Firestone Tire & Rubber Co., predicting that this type of construction will eventually be used throughout the world. Today, there are more than 1000 miles of rubberized asphalt paved roads in various test installations, Firestone said.

16 complete refineries

1945

1. Refinery for B. P. M. at Cardon, Venezuela.
2. Refinery for Koppartrans Oljeaktiebolag at Gothenburg, Sweden.
3. Refinery for Venezuela Gulf Refining Company at Puerto La Cruz, Venezuela.
4. Refinery for Societe Generale des Huiles de Petrole at Dunkirk, France.
5. "Portable" refinery for U. S. Navy Department.
6. Lube oil refinery for Cit-Con Oil Corporation at Lake Charles, Louisiana.
7. Refinery for International Refineries Inc. at Wrenshall, Minnesota.
8. Refinery for Vacuum Oil Company Ltd. at Coryton, England.
9. Refinery for Burmah-Shell Oil Company at Bombay, India.
10. Refinery for Standard-Vacuum Oil Company at Bombay, India.
11. Refinery for Standard Oil Company (Indiana) at Mandan, North Dakota.
12. Refinery for Suntide Refining Company at Corpus Christi, Texas.
13. Refinery for Commonwealth Refining Company at Ponce, Puerto Rico.
14. Refinery for Esso Standard Oil Company at Antwerp, Belgium.
15. Refinery for Caltex at Visakhapatnam, India.
16. Refinery for Neste Oy at Turku, Finland.

1955

In the past 10 years alone, Lummus has completed or is currently working on 16 complete refineries. Combined, they represent a large percentage of the refinery capacity constructed in the last decade.

But complete refineries are only part of the Lummus story. Separate units for any and all phases of refining from distillation to petrochemical production have been designed, engineered and built by Lummus -- as additions to existing installations or as integral parts of new construction.

In the past 50 years, Lummus has added over 700 petroleum and chemical plants and installations to the world's total. Think of Lummus when planning your next project.

THE LUMMUS COMPANY, 385 Madison Avenue, New York 17, N. Y. *Engineering & Sales Offices:* New York, Houston, Montreal, London, Paris, The Hague, Bombay. *Sales Offices:* Chicago, Caracas. *Heat Exchanger Plant:* Honesdale, Pa. *Fabricated Piping Plant:* East Chicago, Indiana.

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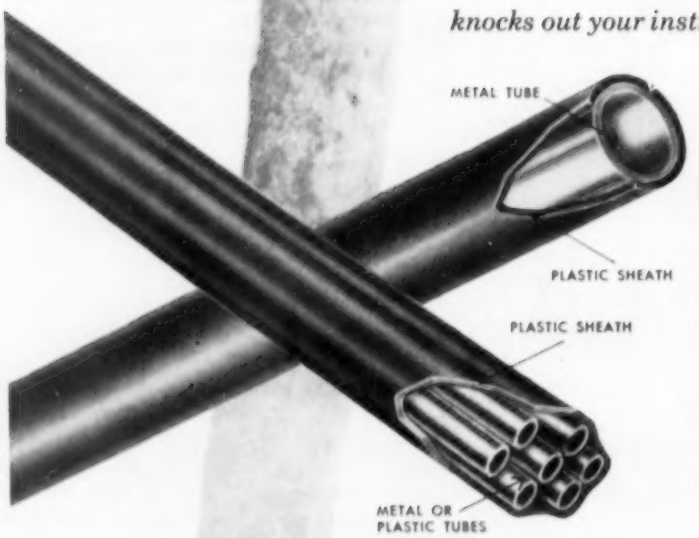
DESIGNING ENGINEERS AND CONSTRUCTORS FOR THE PETROLEUM AND CHEMICAL INDUSTRIES

DEKORON INSTRUMENT TUBING

knocks out your instrument line corrosion problems



DEKORON single-line tubing. Samuel Moore & Co. will coat your copper, aluminum or steel tubing by the Dekoron extrusion process, or will supply coated tubing. Straight lengths to 20 ft., coils to 1000 ft.

DEKORON IMPERVAPAK is a multiple tube harness of plastic or metal tubes encased in tight plastic sheath. Multiple tube construction cuts down installation costs.

Corrosion endangers the life line of your plant—your instrument tubing. That's why you should investigate Dekoron instrument tubing, the tubing that's impervious to moisture, salt air, corrosive atmospheres, and chemicals.

That means Dekoron eliminates replacement costs and maintenance. Other advantages are low initial cost . . . less plant down time . . . easy installation with standard fittings and plastic tape.

In replacement savings alone—not including lower maintenance and installation costs—Dekoron Instrument Tubing pays for itself over and over again.

AA-766

Send for free copy of Bulletin L-6506 "3 Ways to Whip Corrosion and High Tubing Installation Costs in Your Plant."

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DEKORON PRODUCTS DIVISION

MANTUA, OHIO

(To obtain more data on advertised products see page 142)

If You're Looking at Plastic Pipe, Its Day Is Coming, and Fast

TO many of us, the age of plastics is here today—or will be here the very first thing tomorrow. Yet, this is most evident in the field of consumer goods—toys, handy squeeze bottles, unbreakable dishes, items that touch our everyday lives.

But what about the other side of the picture—the use or potential use of plastics in industry? What is its future, for example, in petroleum or petrochemical processing, as a material of construction for piping, fittings, and the like? Recent entry into the field by many large and well-established pipe manufacturers certainly lends emphasis to plastic's growing importance and significance

Engineers thinking about or planning to use plastic pipe will find considerable help in a recent extensive study made by the Plastics Division of Monsanto Chemical Co. The data this study offers should help close the gap between limited knowledge and full knowledge of plastic pipe's advantages, disadvantages, and properties.

In selecting plastic pipe, a choice can be made among seven different materials, each with specific helpful qualities and distinctive shortcomings. Four of these are of relatively great importance: polyethylene, polyvinyl chloride (PVC), polystyrene, and cellulose acetate butyrate. Polyethylene is now used in 80 - 90% of all plastic pipe sold—although it does not have the best physical properties, particularly for petroleum service. PVC is the material being forecast as the replacement for polyethylene, if certain production problems can be licked. The two other leading pipe plastics each account for about 6% of the market.

Physical properties of some plastic pipe will surprise many. At lower temperatures (under 100°F) it seriously challenges conventional materials such as cast iron, copper and brass. For example, polyester-glass fiber pipe at 70°F has a working pressure twice that of copper "L", four times that of cast iron, and 50% greater than brass at the same temperature. It will also resist corrosion from bleach solutions and strong acids, which are weaknesses of the above metals.

But, as do all plastics in their present stage of development, polyester has certain properties that prevent it from being the perfect replacement for cast iron, copper, brass or carbon steel. The disadvantages are susceptibility to caustic solutions, high initial cost (although less than brass or stainless steel), a maximum working temperature of only 275°F, and a high fabrication and installation cost.

Because of the newness of plastic pipe there are many growing pains. Several of the major problems facing the plastic pipe fabricator are: the need for pipe standards, higher extrusion rates to reduce conversion costs, and the expense of establishing marketing facilities. However, within the past year, large producers of metal pipe, i.e., Tube Turns, Crane Co., Carpenter Steel, and others, have entered this market. Not only will this ease the distribution problem but it seems to indicate a fast developing market.

Although the petroleum field is not the largest market for plastic pipe today, Monsanto forecasts that by 1975 it **will be** the largest. Consumption is predicted to climb from today's 5-million lbs./yr. to 66-million lbs./yr. in 1975—a 12-fold increase. And by 1975 the entire potential market for plastic pipe is estimated at 300-million lbs./yr.

The plastics industry recognizes that exploitation of this potential market requires much spade work, technical as well as marketing. Battelle Memorial Institute has been commissioned by the Society of Plastics to determine the useful range and serviceability of four major types of plastic pipe. The results of this study, and others now under way, will do much to define the advantages and limitations of plastic pipe.

As one of the largest potential users of plastic pipe, the oil industry is one of many that can benefit substantially through proper use of this material of tomorrow.

—W.A.B.

Fuels of Widely Varying Properties Will Satisfy Future Heating Needs

NOW, for the first time, refiners have information available in one place on the characteristics of burner fuel oils marketed throughout the U.S. These facts were developed in a nation-wide survey of the five grades sold in 1955. The survey was sponsored by the American Petroleum Institute and conducted by the Bureau of Mines.[1]

There has been a wide variance—even among oils sold in the same geographical area—in the properties considered the best indexes of a burner fuel's suitability: specific gravity, distillation range, and sulfur content.

Despite this variance and the great growth in sales of burner oils in recent years, the oil companies have generally supplied the market satisfactorily. Consumers have not suffered by leaving the product quality in the hands of the competing oil companies and not insisting on narrow, restrictive specifications.

This is borne out by the fact that the actual quality of most distillate and residual fuel oils is superior to the standards set by the specifications of the American Society for Testing Materials.

The five grades of burner oils surveyed by the Bureau included Grades 1 and 2 of the distillate heating oils and Grades 4, 5 and 6 of residual type oils. In the trade, these are variously referred to as heating oil, range oil, furnace oil, "Bunker C," and fuel oil. Data on 341 samples of burner oil are represented. The fuels were produced by 35 refining companies, large and small, in 97 U.S. refineries.

The samples, typical of the five grades of fuel marketed in early 1955, were analyzed by the refiners. Results of the analysis were sent to the Bureau where

the data was studied and tabulated according to the grade and geographic marketing distribution of the fuels represented. There were five geographic areas: Eastern, Southern, Central, Rocky Mountain and Western.

An accompanying table shows the range for the entire U.S. in the properties of No. 2 distillate heating oil, as analyzed in the survey. This grade comprises about 90% of the distillate burner fuels marketed. Even greater range in properties was found for some of the other grades surveyed.

Range in Properties of Grade 2 Heating Oil Sold in the U. S. in 1955

Property	Min.	Max.
Gravity °API	25.8	44.7
Flash Point °F.	126	230
Vis., Kin. at 100 °F.	1.60	4.3
Cloud Test, °F.	−40	28
Pour Point, °F.	60	20
Sulfur, content, Wt.—%	0.03	0.99
Aniline Point, °F.	87	176
Ramsbottom carbon residue on 10% residuum, %	0.003	0.25
Corrosion, 3 hrs. at 122°F.	0	4
Ash, %	0.000	0.01
Water and Sediment, vol.—%	0.00	0.01
Distillation Test:		
I.B.P., °F.	300	460
10%, °F.	368	491
50%, °F.	410	558
90%, °F.	451	648
End Point, °F.	487	708

The importance attached to the data secured through this first survey of burner-fuel oils by oil companies and burner manufacturers has led to a Bureau of Mines and API decision to conduct similar studies annually. The results of the later surveys will show continuing improvement in the quality of these oils marketed because the refiners have available to them new processing techniques and additive treatments to bring this about. Arbitrary and restrictive specifications by any group will eventually handicap the refiners in supplying the burner fuels market with adequate volumes of better products. —V.B.G.

[1] Bureau of Mines Information Circular 7730, "National Survey of Burner-Fuel Oils, 1955"; O. C. Blade, petroleum chemist, Bureau of Mines Petroleum Experiment Station, Bartlesville, Okla.

Atomic Radiation Now Feasible For Chain-Type Reaction Processes

MUCH needs to be known before atomic radiation can be used to produce large volume products in the oil industry—but there is already commercial promise in the manufacture of certain petrochemicals.

We need an atomic radiation method that will start a chain reaction within the treated material to make radiation processing feasible, according to Dr. Charles L. Thomas, associate director of research and development of Sun Oil Co., during an interview for "Our Sun," their company magazine.

The conversion of one molecule by atomic radiation must in turn cause another molecule to convert, and so on. Small scale experiments of this type on crude and gasoline stocks have given very small yields so far. But because many researchers blame experimental difficulties, there is still hope that an atomic refinery might be developed on this principle.

Petrochemical applications of atomic radiation are more encouraging. Esso Research and Engineering Co. recently announced[1] advances in both polymerization and degradation of polymers. They cited the rapid polymerization of methyl methacrylate by gamma rays.

In addition, Dr. Thomas states that atomic bombardment of ethylene by a source equal to one ton of radium would yield about 2,000 t/yr of polyethylene. The advantage here is that the polymerization of ethylene is of the chain-type reaction which can be initiated by atomic radiation.

Other possible atomic applications which have received little attention in the refinery—because of the glamour of radiation induced process reactions—include tailoring of entirely new catalysts[2] and replacing the conventional power and heat sources used in refineries.

The big drawbacks in all of these possibilities seem to be cost and safety. Once these problems are solved, we may be well on our way to atomic petroleum processing. —R.L.D.

[1] Anon., "New Promise in Gamma Rays As a Petroleum Processing Tool," Petroleum Processing, Jan., 1956, pp. 15-16.
[2] Anon., "Neutron Irradiation Gives Clue to New Types of Catalysts," Petroleum Processing, Feb., 1956, pg. 16.

Are Computers Spelling Out The End of the Pilot Plant Shop?

LONG a dream but not yet a reality for processing technology is the elimination of the pilot plant and semi-works stage in the development of a new process for commercial use.

Except for the now-fabled "miracle" job performed by the industry in building synthetic rubber plants from "scratch" during World War II, virtually all process development today still requires some very extensive and costly work between the laboratory and the final full-scale plant.

A change may soon be here, if some of the "practical dreamers" now studying applications for computers have their way. One of the most intriguing jobs the new electronic brains are expected to do is acting as a substitute for the pilot plant.

Up to now, pilot plant work has been regarded as a necessity. Too many dollars are involved in the final plant to risk taking a process directly from the lab to full-scale. The pilot operation can prove out a process idea at a considerable saving.

Where a computer fits in the picture is in providing a means for simulating the actual conditions mathematically, and then providing results in mathematical terms which can be interpreted in terms of actual product results.

How soon is anybody's guess, but some of the oil companies working with computers are betting that very little if any pilot plants will be built once the computers get to work. —W.C.U.

STRUTHERS WELLS

MIXING VESSEL

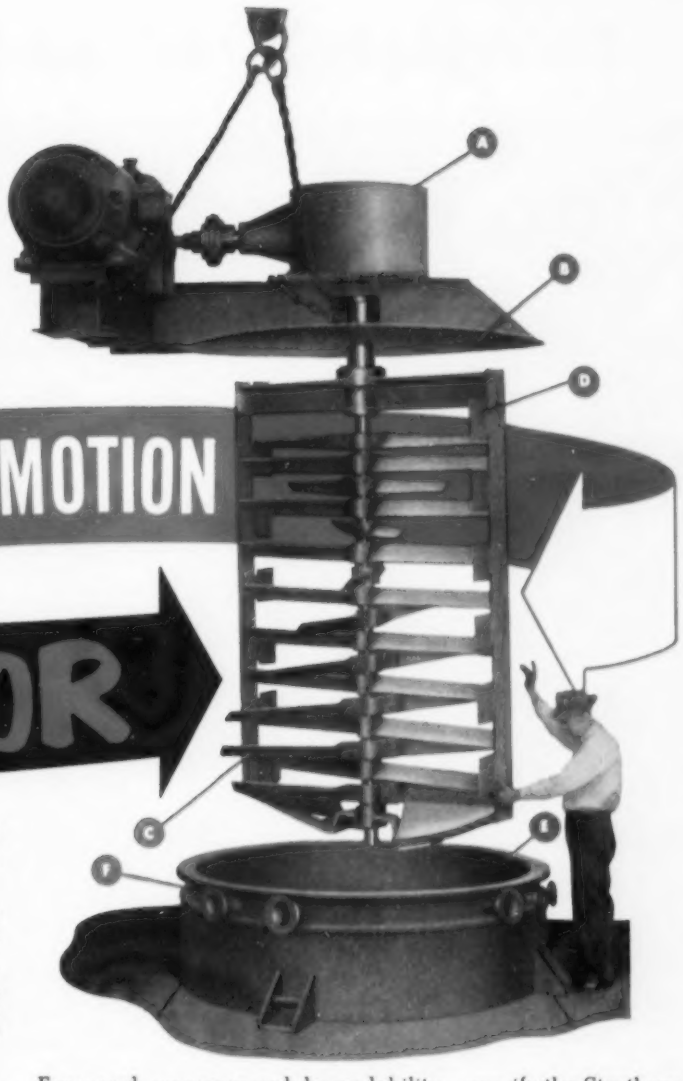
FOR PROCESSING

HEAVY VISCOUS

MATERIALS

Struthers Wells DOUBLE MOTION

AGITATOR



A Double motion drivehead, an exclusive Struthers Wells design. Horsepowers from 2 to 150. Furnished with sealing devices when used on pressure kettles.

B Kettles can be open flat top, or dished and flanged closed top for working pressures as high as 300 lbs.

C Sweep and paddle arms are pitched to create flow of material throughout kettle—preventing stratifying of the mix. Scraper frame and paddle arms can be of welded design or bolted for easy removal when vessel is equipped with a cover.

D Scraper blades are advanced hinged type, which insures positive scraping action on 98% of the inside surface of mixer.

E Mixer can be fabricated of steel or special alloy to meet specifications.

F Kettles furnished with jacket or unjacketed for possible direct fire application.

For speed, economy and dependability—specify the Struthers Wells Double Motion Mixing Vessels—for processing greases and other heavy viscous materials. Our extensive machine shops and fabricating facilities—combined with years of engineering experience in designing all types of agitating vessels, enable us to furnish mixing equipment for any material, to your most rigid specifications.

For intricately designed or standard mixing equipment—*think first of Struthers Wells.*

STRUTHERS WELLS PRODUCTS

PROCESSING EQUIPMENT DIVISION

Crystallizers . . . Direct Fired Heaters . . . Evaporators . . . Heat Exchangers . . . Mixing and Blending Units . . . Quick Opening Doors . . . Special Carbon and Alloy Processing Vessels . . . Synthesis Converters

BOILER DIVISION

BOILERS for Power and Heat . . . High and Low Pressure . . . Water Tube . . . Fire Tube . . . Package Units

FORGE DIVISION

Crankshafts . . . Pressure Vessels . . . Hydraulic Cylinders . . . Shafting . . . Straightening and Back-up Rolls

MACHINERY DIVISION

MACHINERY for Sheet and Structural Metal Forming . . . Tangent Benders . . . Folding Machines . . . Roller Table and Tumble Die Bending Machines . . . Press Brakes . . . Punching and Notching Machines . . . Forming Dies

STRUTHERS WELLS *Corporation*

Struthers Wells

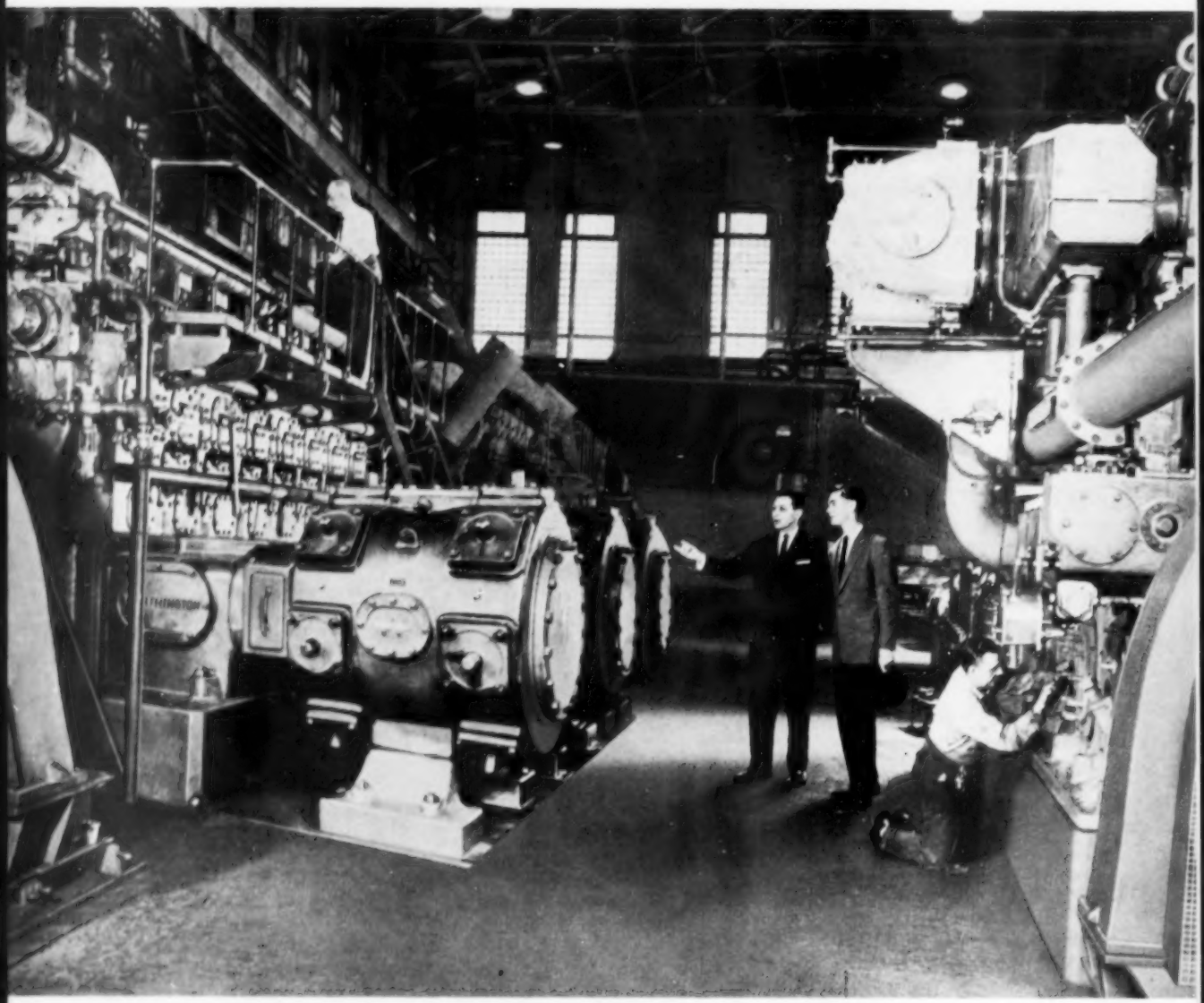
WARREN, PA.

PLANTS AT WARREN, PA. AND TITUSVILLE, PA.

Offices in Principal Cities

(To obtain more data on advertised products see page 142)

Complete process-flow flexibility



Progressive engineering gives you more for your engine compressor dollar in the TURBO-UNIFLO

AFTERCOOLING FOR MAXIMUM LOAD CAPACITY. Air inlet manifold temperatures must be kept reasonably low to maintain wide engine operational range and overload capacity. This is important in high ambient temperature locations. Low cycle temperatures reduce maintenance on liners, heads, and pistons. Individual aftercoolers mounted immediately adjacent each cylinder inlet give maximum load capacity with accessibility.

MORE POWER FROM TURBO-UNIFLO DESIGN. Only cam-operated, timed exhaust valves permit early opening of exhaust to give complete evacuation of burnt gases, and controlled closing for trapping maximum supercharging air. Coupled with pulse-generator ignition, this quiet chain driven timing system gives top performance with minimum maintenance.

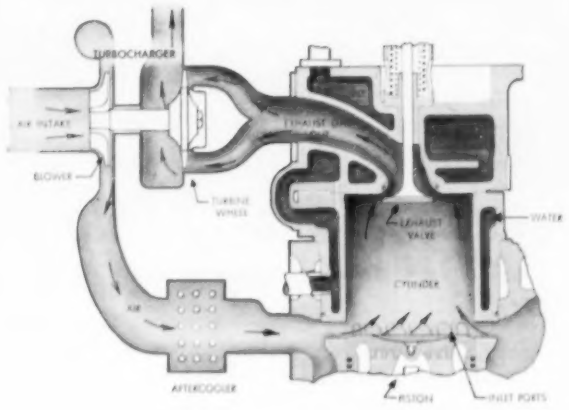
The only turbocharged 2-cycle engine compressor with

with 2-cycle compactness...

NO POWER-DRAINING EXTRA DRIVE FOR SUPERCHARGING WITH THE "TURBO-UNIFLO"— WORTHINGTON'S SUTC GAS-ENGINE COMPRESSOR

In its first production year this unique two-cycle turbocharged gas-engine compressor (750 to 2500 hp) has had remarkable process industries acceptance. Designed for quiet exhaust-powered pulse-type turbocharging on the basis of Worthington's extensive two-cycle engine-compressor experience, more than twenty-four TURBO-UNIFLO SUTC's are either installed or on order.

By integrating exhaust-powered turbocharging with field proven Worthington Uniflo scavenging design, Worthington engineers have developed a two-cycle engine-compressor unequalled for stability of performance over the *complete* range of speed and load requirements. Operating at relatively high compression ratio, the TURBO-UNIFLO has much smoother combustion characteristics than other engines with lower compression ratios. This is due to the basic timing arrangement, engine configuration, and design of exhaust manifolding. Sufficient exhaust gas energy is applied at the turbocharger, from engine start-up through all speeds and loads, to give full turbocharged effect without added external mechanical means for driving the supercharger. Low fuel and lube oil consumption are other advantages.



TURBO-UNIFLO OPERATION — Exhaust valves are timed to open and generate a pressure pulse to move the turbine blades. This gives self-sustained starting and quick acceleration without external aid or mechanical drive. Blower delivers air under pressure to the aftercooler. Cooled air enters the cylinders through inlet ports 360° around the liner. During the scavenging period, the combustion chamber walls and valves are effectively cooled.

The Uniflo system is accepted as having highest scavenging efficiency. It also gives the best turbocharging-scavenge ratio due to complete absence of residual gases in the combustion chamber.

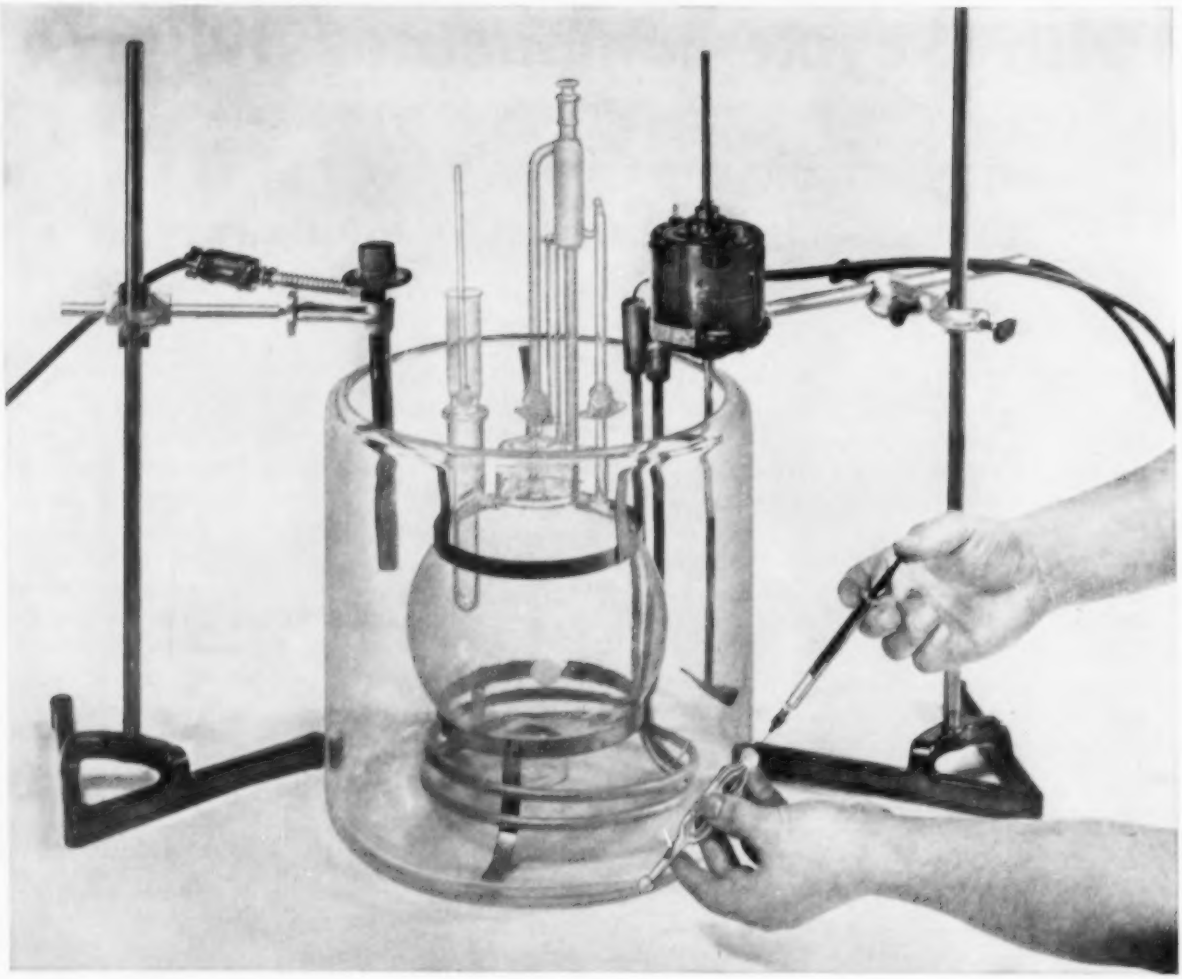
QUIETER OPERATION. Cast-iron exhaust manifolding — dry insulated, built-in air-pulse dampener, triple-strand silent camshaft chain, hydraulic valve lifters and elimination of any mechanically-driven air charging device assure quietness.

FEATHER VALVE. The feather valve is standard TURBO-UNIFLO equipment. It's the lightest, simplest and quietest valve—and operates with no impact!

For more details on the TURBO-UNIFLO, call your nearest Worthington District Office, or write Worthington Corporation, A&SP-Engines, Harrison, New Jersey.

WORTHINGTON

exhaust-powered turbocharging from start-up through full-load



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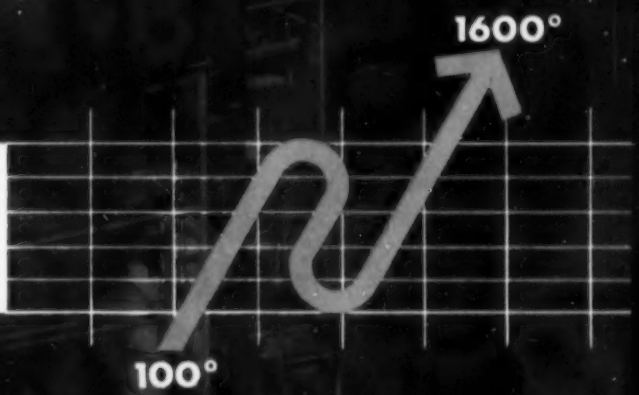

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it's the **CATALYST** that counts

ATLANTIC

(To obtain more data on advertised products see page 142)

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How to slash handling costs and downtime right now!

FROM THE MOMENT SPUDDING STARTS until the end product reaches the consumer, breakdowns chop profits and waste time. To avoid these headaches, many engineers specify Boston hose and belting. They've discovered Boston products handle the toughest jobs—turn in reliable performance on every job.

BUT THAT'S ONLY NATURAL! Boston *specializes* in rubber products for industrial use. And because it isn't just a sideline, Boston has only one aim: to continue developing products that dollar-for-dollar outperform all others.

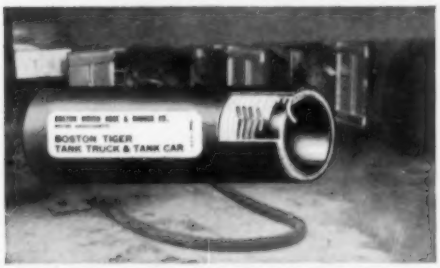
FAST DELIVERY WHEN YOU NEED IT, is next in importance after good performance. Your Boston distributor knows that. He keeps a supply of Boston hose and belting ready to meet your needs. And he knows your problems as well as he knows industrial rubber products. That's why he's your Boston Man! Call him today.

BOSTON HEAVY DUTY OIL HOSE: For loading and unloading tankers and barges. Boston has a full line of oil suction and discharge hose—all time-tested, proved sturdy. Boston hose is furnished with built-in steel or duralumin nipples. Get full details from your Boston Man.

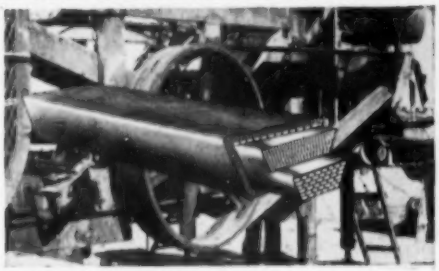
INDUSTRIAL HOSE • FIRE HOSE • BELTING

(To obtain more data on advertised products see page 142)

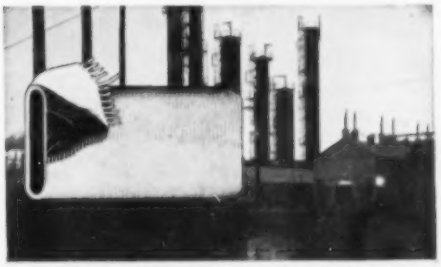
BOSTON CHECKLIST FOR YOUR HOSE AND BELTING REQUIREMENTS



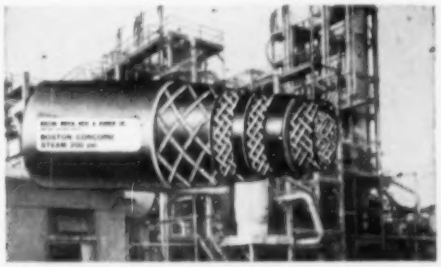
BOSTON TANK TRUCK AND FUEL OIL HOSE: Boston's seamless, synthetic tube won't flake or soften because it is unaffected by gasoline, oil, and other fuels. That means more rapid fuel transfer under all conditions. Your Boston Man will help you select the right hose for your jobs.



BOSTON V-BELTS: Muscles of tough, special cord brace *all* Boston V-Belts against slippage and shock loads. That's why they require less maintenance than other belts, deliver power more smoothly, efficiently and economically. Get the right belt for your job from your Boston Man.



BOSTON CHEMICAL AND FIRE HOSE: Boston's complete line of chemical and fire hose lasts longer even under the toughest conditions. That's because every Boston hose is designed for a specific job, engineered to do that job more effectively. Put Boston hose to work to protect your plant!



BOSTON STEAM HOSE: Built with safety to spare, Boston Steam Hose eliminates breakdowns and handling problems on cleaning and maintenance jobs; Boston's complete line of wire-reinforced and wrapped fabric steam hose is made with time-tested, heat-resistant compounds.

BOSTON SERVICE STATION HOSE: Air hose and gasoline Curb Pump hose used in service stations must absorb rough handling, weather, dirt, grease. Boston hose is designed to take this kind of punishment. There's a full line of Boston maintenance hose for air, water and steam applications.

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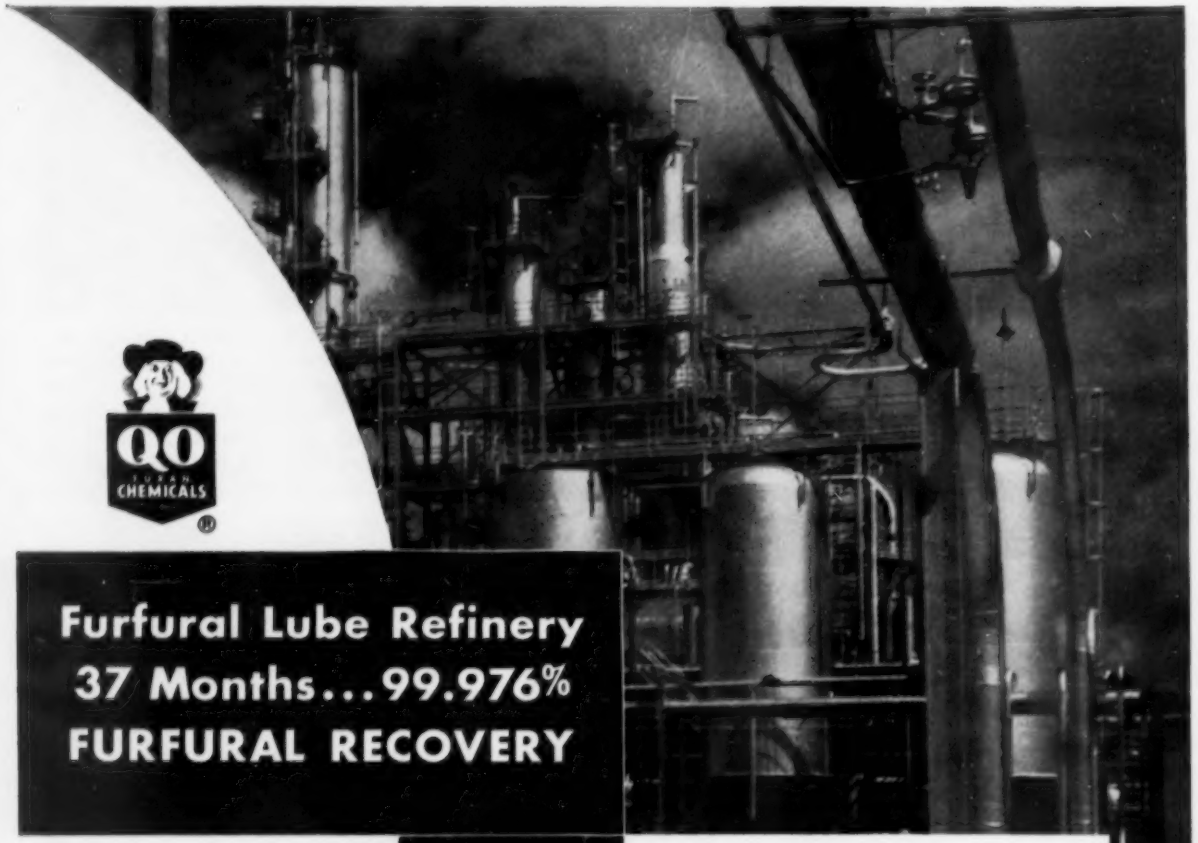

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Furfural Lube Refinery 37 Months...99.976% FURFURAL RECOVERY

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In addition to stability QO furfural offers high selectivity, low cost, easy handling, year round availability, economical storage and safety. No wonder QO furfural is first choice of more than 40 refiners throughout the world.

Be sure to write for our new Bulletin 203-A "Physical Data on QO Furfural".

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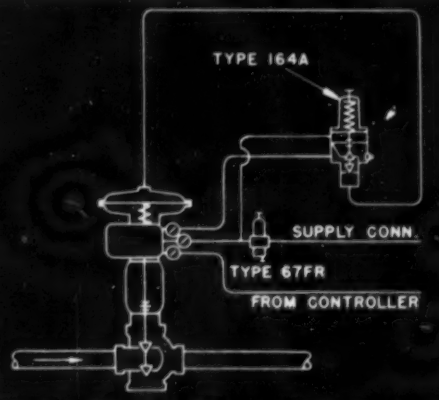
FISHER® SERIES 164

For "Gadgeteering" Control

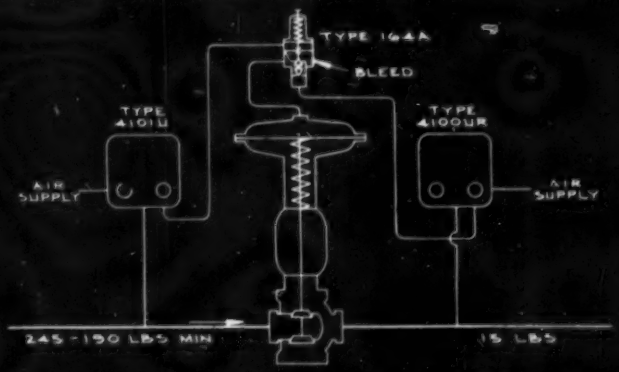
SUCH AS

TWO-WAY ACTION for SAFETY LOCK-UP

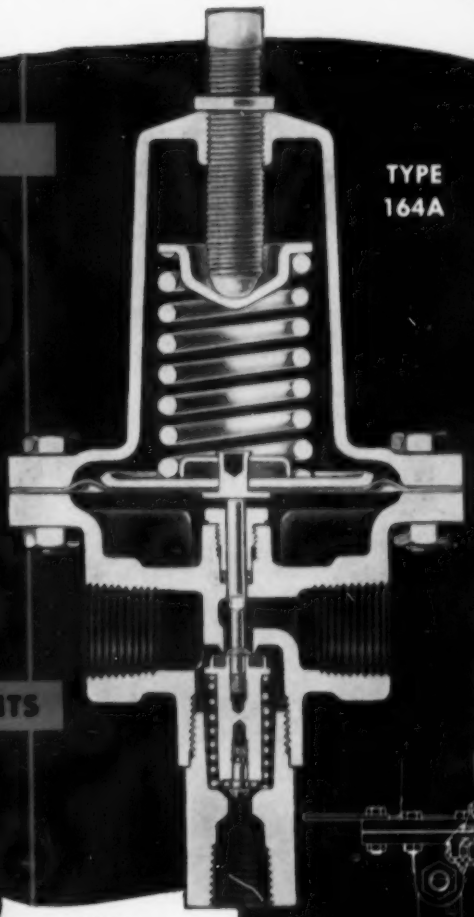


Lock-up system using Type 164A to close air circuit to diaphragm of main valve in case of plant air failure. Main valve will be held in position at time of supply pressure failure.

or THREE-WAY ACTION for SWITCH AIR CIRCUITS



Pressure reduction normally handled by 4100UR Wizard. If inlet pressure to main valve falls below a predetermined amount Type 4101U snap-acting Wizard bleeds pressure off Type 164A switching valve causing 3-way valve to change position so as to close control line pressure and bleed main valve diaphragm pressure to atmosphere. Main valve will stay closed until inlet pressure is restored to desired amount.



- SMALL
- COMPACT
- SELF CONTAINED

Side view of Type 164 Showing ¼" Control Line Connection. Control Chamber is separate from body chamber.

SIZES ¼" or ½"

CONTROL SPRING RANGES PSI	PRESSURE CHANGE ON DIAPHRAGM FOR FULL VALVE STROKE, PSI
3 to 15	2
5 to 20	2½
5 to 35	4
30 to 60	5¾

MATERIALS

Zinc die cast body and spring case, composition diaphragm and valve disc.

FISHER GOVERNOR COMPANY
MARSHALLTOWN, IOWA
CANADIAN PLANT: WOODSTOCK, ONTARIO
WORLD LEADER IN RESEARCH FOR BETTER PRESSURE AND LIQUID LEVEL CONTROL

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YARWAY IMPULSE STEAM TRAP

the only moving part

...a small stainless steel valve that literally floats on the condensate load. Gets equipment *hot in a hurry*—and *keeps it hot!*

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Today—over a million YARWAY Impulse Steam Traps later—advantages like the following continue to convert new users, and convince old users to standardize on the YARWAY Impulse:

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- GOOD FOR ALL PRESSURES WITHOUT CHANGE OF VALVE OR SEAT
- SMALL SIZE—LIGHT WEIGHT
- ONLY ONE MOVING PART
- STAINLESS STEEL—minimum maintenance
- WON'T FREEZE UP
- A COMPLETE LINE of sizes and types for every requirement
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For all *normal* trap requirements, pressures to 400 and 600 psi.

½" No. 20-A

For *light loads* on tracer lines, steam mains, small presses, etc.

SERIES 40

For *heavy loads* requiring extra high capacity steam traps.

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For *high pressures, high temperatures.* (Flanged or welding connections.)

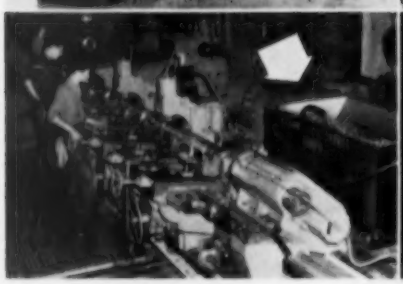
YARWAY **IMPULSE® STEAM TRAP**

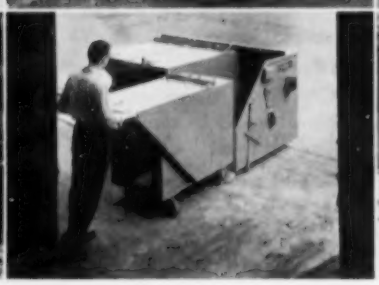
OVER 1,000,000 YARWAY IMPULSE STEAM TRAPS USED

(To obtain more data on advertised products see page 142)

Here's the most versatile....lowest cost of bulk materials handling by truck ever

With only one man, it PICKS UP . . . HAULS . . . Serves scores of big steel containers, all sizes and





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ABOVE ARE BUT A FEW of the hundreds of different Dempster-Dumpster Detachable Containers at work in industry today—containers built in capacities up to 21 cu. yds. . . . several times the capacity of the average dump truck body. It's like having one truck with scores of bodies!

method devised!

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and DUMPS (or sets load down intact) designs — handling materials of every description

WITH NO OBLIGATION on your part, our engineers will be glad to make a comprehensive fact-finding survey to determine the cost-cutting possibilities of this equipment in your plant. Ask us for complete information. Manufactured exclusively by Dempster Brothers, Inc.

DEMPSTER BROTHERS

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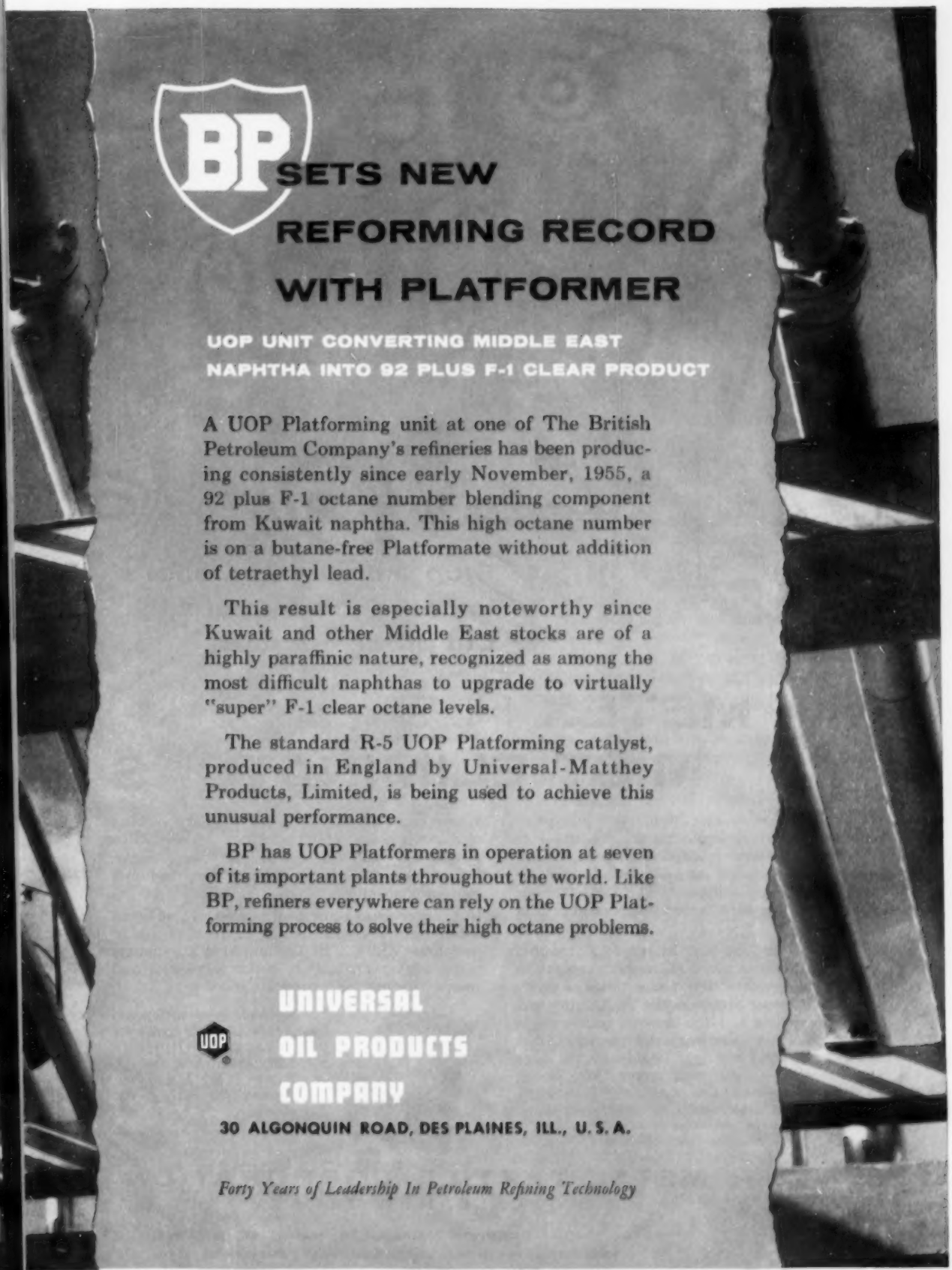
BP SETS NEW
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WITH PLATFORMER
UOP UNIT CONVERTING MIDDLE EAST
NAPHTHA INTO 92 PLUS F-1 CLEAR PRODUCT
A UOP Platforming unit at one of The British Petroleum Company's refineries has been producing consistently since early November, 1955, a 92 plus F-1 octane number blending component from Kuwait naphtha. This high octane number is on a butane-free Platformate without addition of tetraethyl lead.
This result is especially noteworthy since Kuwait and other Middle East stocks are of a highly paraffinic nature, recognized as among the most difficult naphthas to upgrade to virtually "super" F-1 clear octane levels.
The standard R-5 UOP Platforming catalyst, produced in England by Universal-Matthey Products, Limited, is being used to achieve this unusual performance.
BP has UOP Platformers in operation at seven of its important plants throughout the world. Like BP, refiners everywhere can rely on the UOP Platforming process to solve their high octane problems.
UOP
UNIVERSAL
OIL PRODUCTS
COMPANY
30 ALGONQUIN ROAD, DES PLAINES, ILL., U. S. A.
Forty Years of Leadership In Petroleum Refining Technology

✔ Stop entrainment losses
✔ Improve product quality
✔ Cut process costs

with METEX Hi-Thruput MIST ELIMINATORS

Collection and recovery of valuable liquid products — removal of liquid particles harmful to subsequent processes — reduced equipment maintenance and decreased air pollution . . . these are but a few of the possibilities METEX Hi-Thruput Mist Eliminators offer to alert process and project engineers.

METEX Hi-Thruput Mist Eliminators, installed in a process tower or vessel, effect sharp separation of entrained liquids within a wide range of vapor velocities. Pressure drop is negligible. Quality and yield are increased. High removal efficiency is maintained, even at extreme temperatures, due to free-drainage of impinged liquids. Liquid slugs cannot enter turbines or compressors. Coke formation is minimized and life expectancy is substantially increased even under adverse conditions.

Where solids may be formed in the mesh because of decomposition, polymerization, crystallization or freezing, METEX Hi-Thruput Mist Eliminators provide up to three times the service life of conventional units.

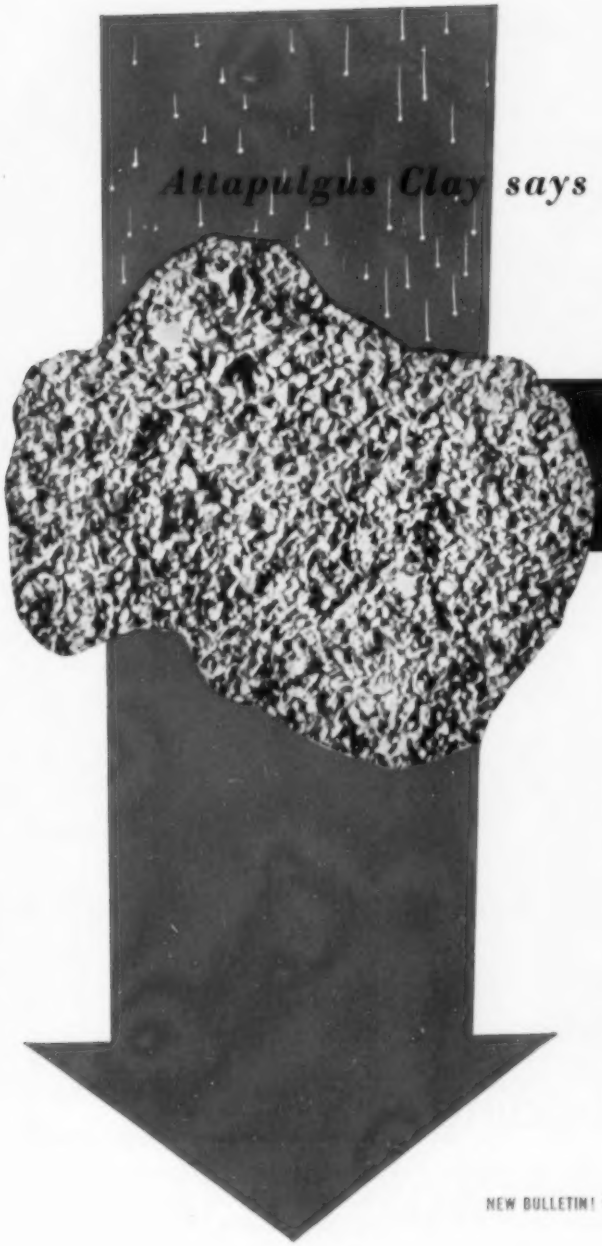
In any processing equipment or vessel where liquid entrainment is a contributing factor in design or operation, METEX Hi-Thruput Mist Eliminators assure higher production, better processing and lower operating and maintenance costs.

For complete information and specifications, write today for your copy of Bulletin ME-106, illustrating and describing METEX Mist Eliminators for all process equipment.

METEX QUALITY PRODUCTS 6-075

METAL TEXTILE CORPORATION
ROSELLE, NEW JERSEY

METAL TEXTILE CORP. OF CANADA, LTD., HAMILTON, ONTARIO
Representatives in principal cities throughout the world



Attapulgus Clay says **STOP!**

to
Platinum Catalyst
poisons

Attapulgus Clay keeps strict watch over your catalytic reforming feed stocks, protects you against losses caused by catalyst poisoning. It does this by effectively reducing the detrimental constituents that temporarily (sometimes permanently) foul the catalyst.

Here are the troublemakers (some need only be present at 10 parts per billion) that Attapulgus Clay removes from the stream: Arsenic—either present in the crude, or picked up from equipment; Tetraethyl Lead—from refinery cross-contamination; Alkyl Sulfur compounds; Nitrogen—from crude or other sources.

Setting up this effective clay treatment safeguard can be accomplished at a surprisingly low investment—one that pays out promptly in terms of the most favorable production rate.

This is another solid example of how M&C products keep growing in value to refiners. There's always a *new place* for these versatile minerals to improve the quality and cut the processing costs of petroleum products.

NEW BULLETIN! "Preparation of Petroleum Feeds for Platinum Catalysts"
is just off press. Check the coupon for prompt mailing of your personal copy, and for other assistance, if desired.

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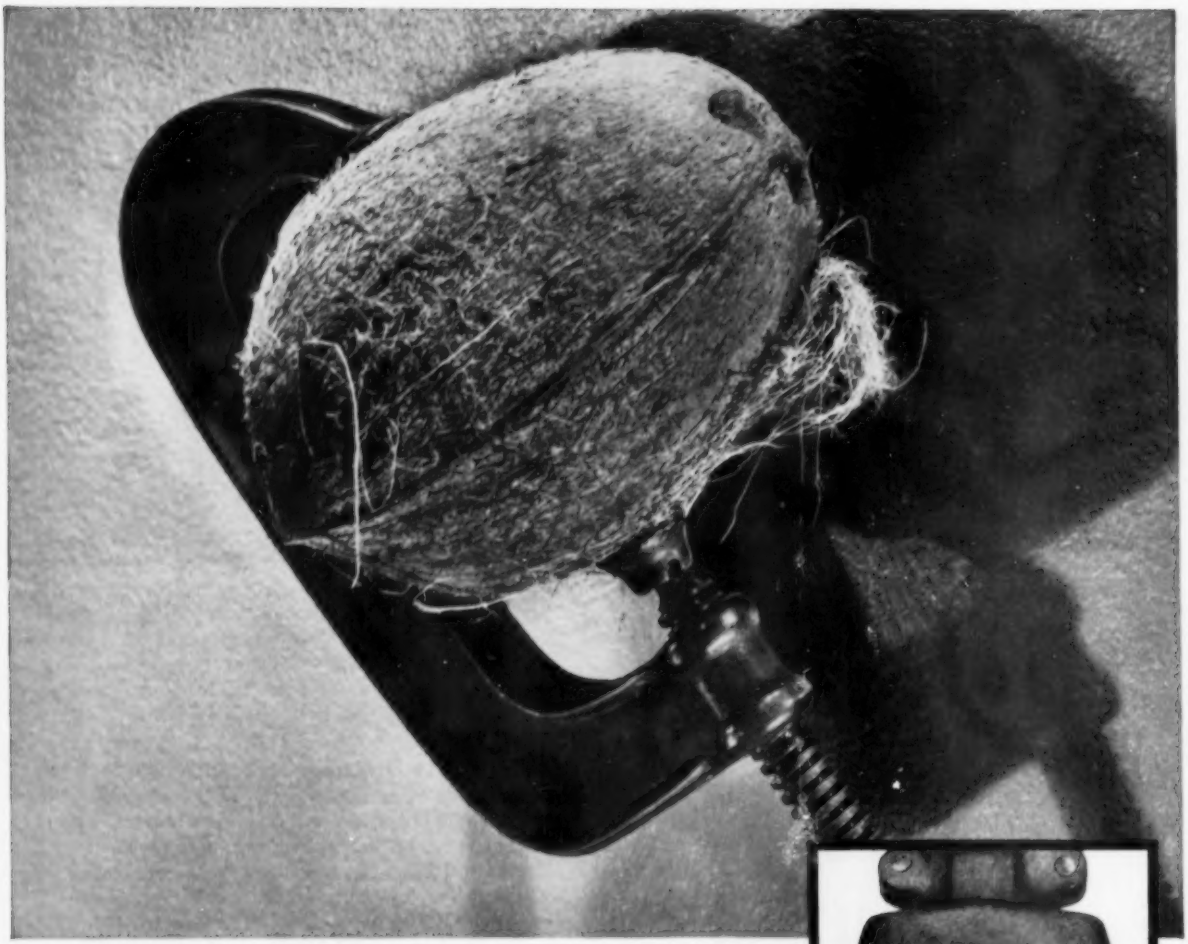
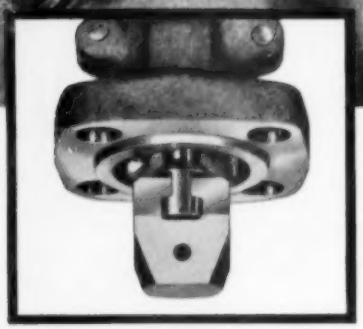
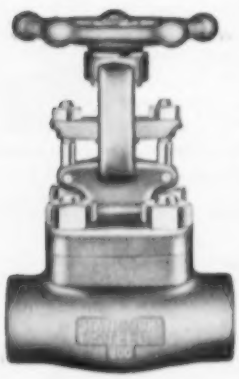


STAMINA

that takes heavy loading



THE STEM-WEDGE CONNECTION in Type 950 Hancock Steel Gate Valve won't bend or fracture even if corrosion prevents opening the valve. So strong is the connection that destructive "cheater" loading on the handwheel will first break the stem thread. The operator thus knows that the valve is still closed and can act to safeguard equipment and avoid shutdowns.



This ultra-strong stem-wedge connection, *an exclusive Hancock design*, overcomes a structural weakness widely recognized in other small gate valves. Its balanced design also places the "T" head slot in the wedge so that the stem can move freely, even though flow forces the wedge against the guides. It is a powerful example of the quality that makes Type 950 Hancock Steel Gate Valves perform better and longer in the severest services. Call your Industrial Supply Distributor for full details today.

HANCOCK VALVES

A product of

MANNING, MAXWELL & MOORE, INC.

Watertown 72, Massachusetts

In Canada: *Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario*

Why gamble your profits?

Valves are a major investment. Why gamble your profits on risky valves when you can buy the best at a price that is often lower than ordinary valves? Your valve investments are secure when you specify Rockwell-Nordstrom valves because *pressurized lubrication* assures economy and dependability in these three important ways:

1. Leakproof Sealing . . . eliminates uncertain, "forced" metal-to-metal seating.

2. Longer Life . . . lubricant stops trouble before it starts . . . slashes repair, maintenance and down time costs.

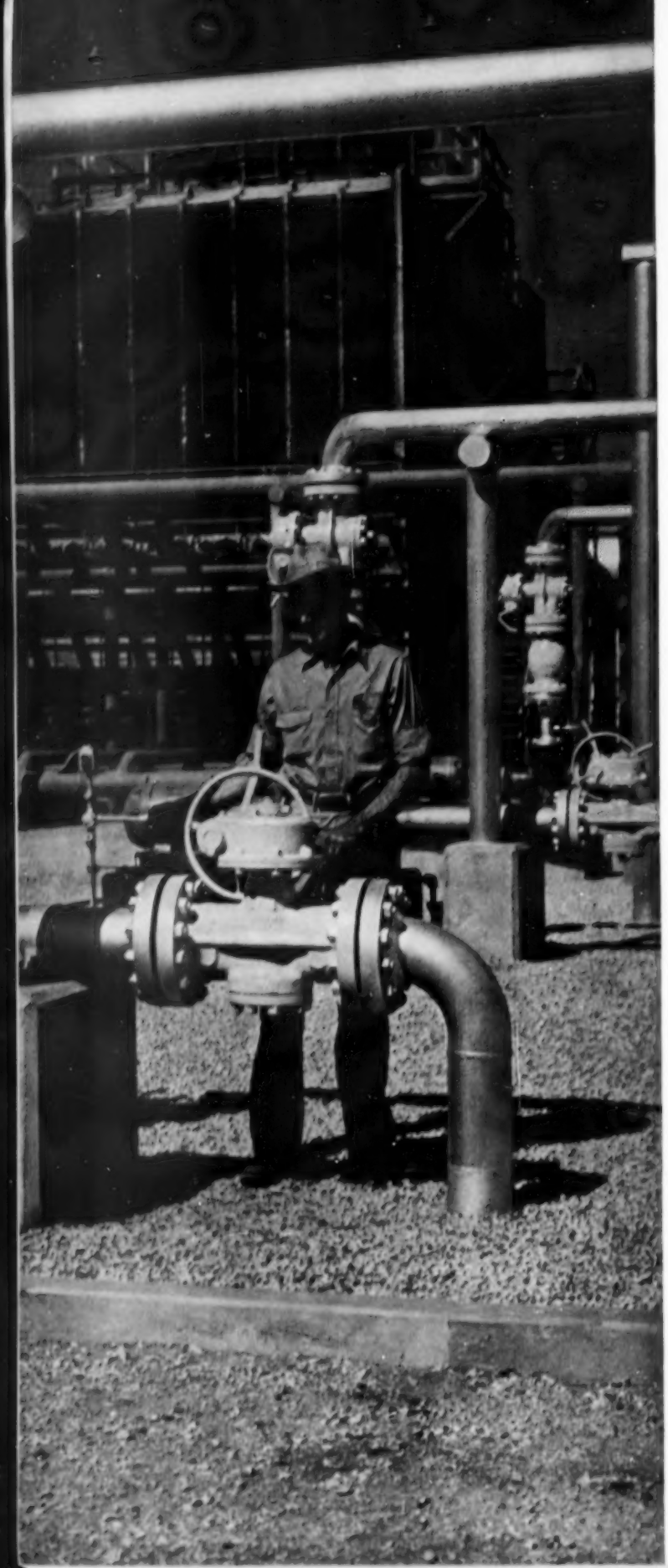
3. Instant Operation . . , lubricant "cushions" plug for smooth, quarter-turn operation.

Forty years of lubricated plug valve leadership by the original and world's largest manufacturer is your assurance of economy and trouble-free dependability when you specify Rockwell-Nordstrom valves. Rockwell Manufacturing Company, Pittsburgh 8, Pa.

ROCKWELL-Nordstrom VALVES

Lubricant Sealed for Positive Shut-off

40th Year *of lubricated plug valve leadership*



How to handle tough services

Many services (like high-velocity gas service) eat the heart right out of ordinary valves. Metal-to-metal seating soon becomes pitted or scored and the valve won't hold. The result—expensive reseating, down time and snarled production schedules.

In Rockwell-Nordstrom valves a thin, tough film of pressurized lubricant between the plug and the valve body forms a *continuous* and *dependable* seal at any pressure on any service. The lubricant also protects against corrosive-erosive material and eliminates metal-to-metal friction for longer service life at lowest cost.

Rockwell-Nordstrom, *the original and most complete line* of lubricated plug valves are available in steel, semi-steel, stainless steel and special alloys for a complete range of pressures and temperatures. For more information, write: Rockwell Manufacturing Company, Pittsburgh 8, Pennsylvania.

Available at leading suppliers . . . everywhere.

ROCKWELL-
Nordstrom
VALVES

Lubricant Sealed for Positive Shut-off

40th Year
of lubricated plug valve leadership

OHIO'S ANNOUNCING

THE ALL-NEW OHIO TYPE 1500 RETURN BEND

HEADING UP OPERATION

SELF-CONTAINED CLOSURE MECHANISM; all parts handle as a unit when heading up or unheading.

UNHEADING . . . FAST!

POSITIVE PLUG PULLER DEVICE incorporated in closure mechanism.

NO PULLING TOOLS REQUIRED. One wrench backing off set collar also serves as a plug puller. Set collar is backed off until it becomes engaged with standard hex nut on plug stem. Additional turn of set collar forces release of plug while threads are still engaged.

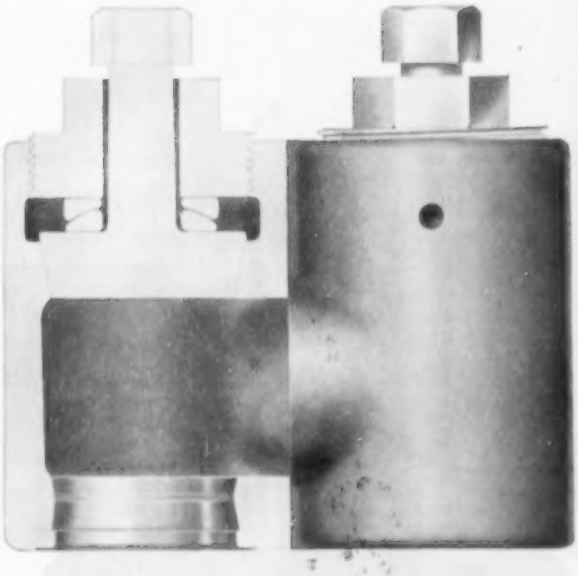
SAFE!

SAFETY FEATURE: Plug cannot blow out. Trapped gases relieved through weep-holes while set collar is still engaged in fitting.

STRENGTH OF CLOSURE DESIGN

Uniform stress in tension and shear about holding mechanism and body casting at all times. Floating set collar eliminates thread galling and/or thread seizure, thus insuring easy removal. Convex and concave surfaces of the equalizing rings assure proper alignment between set collar and plug.

BENDING OF SET COLLAR ELIMINATED BY 360° PROJECTION AND BEARING!



OHIO TYPE 1500 RETURN BEND
(Patent applied for)

FOUR SERIES

850-1275-1700-2000

TEN SIZES IN EACH SERIES

2" to 6-5/8"

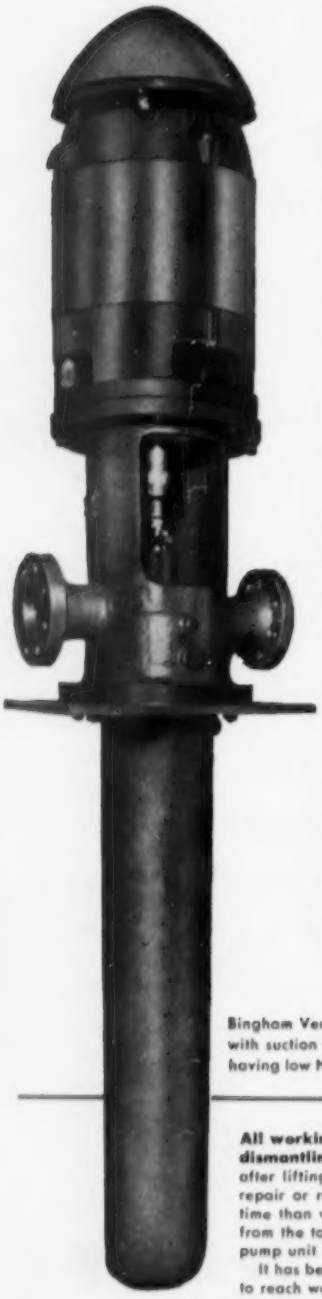
Write for information and prices

THE OHIO STEEL FOUNDRY COMPANY

ENGINEERS • FOUNDERS • MACHINISTS • FABRICATORS

LIMA, OHIO Plants at Lima and Springfield, Ohio

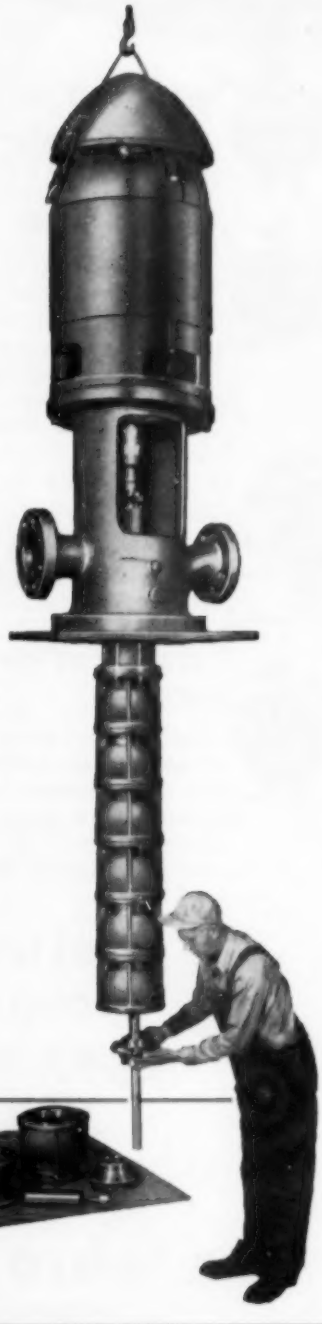
NEW! Bingham ALL WORKING PARTS



Besides bottom dismantling, which in itself greatly reduces maintenance time when attention is required, this new Bingham pump incorporates advanced design features which minimize maintenance, reducing the need for periodic inspection.

For example, all intermediate bearings (supplied of appropriate material for different pumpages) are forced-lubricated by the pumpage. Diagram at right shows this feature and, in addition, shows how bottom bearing is lubricated even if the pump runs dry for short periods. This *dependable* lubrication greatly prolongs the life of bearings, which in conventional pumps are frequently the cause of maintenance shutdowns.

Wherever it has been installed, the new Bingham VCP Pump has given trouble-free service—plus unsurpassed smooth operation with no vibration. Available for any capacity or head. Write your nearest Bingham office for additional information.



Bingham Vertical VCP assembled with suction well for installations having low NPSH conditions.

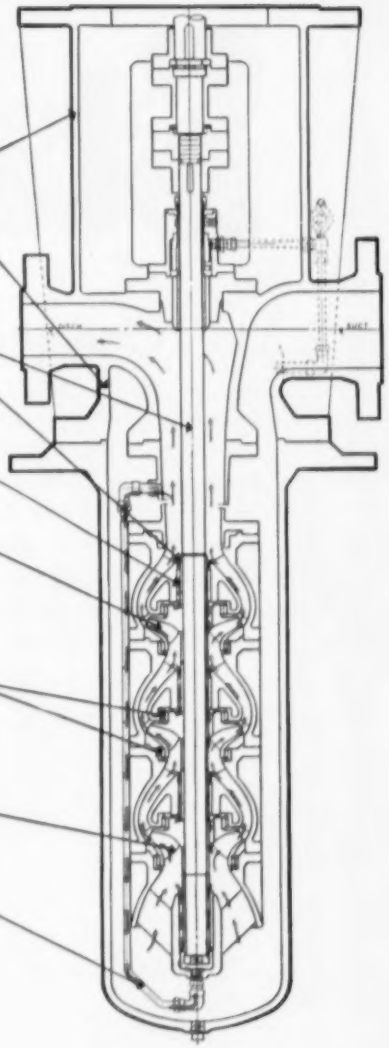
All working parts of pump easily accessible with bottom dismantling. One man can service the Bingham VCP Pump after lifting pump from well. By dismantling from the bottom, repair or replacement of any part can be made in much less time than with conventional pumps (where dismantling begins from the top, necessitating removal of driver and head before pump unit is accessible).

It has been estimated by various operators that time required to reach working parts has been reduced as much as 50%.

VCP VERTICAL PUMP FOR LOW NPSH
ACCESSIBLE WITH BOTTOM DISMANTLING

ONLY *Bingham* OFFERS ALL THESE BENEFITS:

1. Heavy-duty steel suction and discharge head rigidly built to eliminate vibration caused by drivers.
2. Shaft is maximum diameter throughout.
3. Shafts are equipped with renewable 11-13 chrome, hardened, ground and polished sleeves at each bearing.
4. Bearings are of the appropriate material for the different pumpages.
5. Maximum head per stage and maximum efficiency for a given capacity range.
6. Front and back wearing rings on enclosed type impellers permit a one-stage pressure drop over each bearing for lubrication purposes.
7. Wear rings reduce thrust of rotating element, permitting use of standard motors.
8. Maximum eye area of bottom impeller for lowest possible NPSH.
9. Bottom bearing lubricated by pumpage taken from the discharge column, which, together with connecting pipe, acts as a reservoir for bearing lubrication in event pump operates "dry" for short periods.



Bingham SINCE 1921

DOUBLE VOLUTE PUMPS RADIAL BALANCE

BINGHAM PUMP COMPANY
***General Offices:* 2800 N.W. Front Avenue, Portland 10, Oregon**
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TORONTO, ONT., CAN.
VANCOUVER, B. C., CAN.

(To obtain more data on advertised products see page 142)

Stability,

. . . a basic ingredient in Davison's Petroleum Catalysts

Davison achieves it through control of filament size and orientation (see illustration below). Davison catalysts possess greater mechanical strength because of their larger filament diameters. The orientation of these filaments provides a catalyst of large pore diameters.

These two factors combine to give Davison catalysts longer life through greater stability.

Davison has for many years been the leader in the production of catalysts. This leadership has been maintained through Davison's continuing ability to produce catalysts designed to meet the requirements of all types of fluid catalytic cracking units.

For information on Davison catalysts, see your Davison Representative, or write

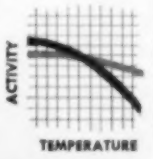
DAVISON CHEMICAL COMPANY
Division of W. R. Grace & Co.
Baltimore 3, Maryland

Sales Offices: Chicago, Ill.; Houston, Tex.; New York, N.Y.; Baltimore, Md.
In Canada: Davison Chemical Company Ltd., Toronto

Producers of: Catalysts, Inorganic Acids, Superphosphates, Triple Superphosphates, Phosphate Rock, Silica Gels and Silicofluorides. Sole Producers of DAVCO® Granulated Fertilizers.

Structural Stability. Catalyst in the form of submicroscopic filaments provides the surface area on which catalytic reactions take place. Large filaments give greater mechanical strength.

Thermal Stability. The graph compares high pore diameter catalysts (in blue) with ordinary catalysts. By resisting heat deactivation, high pore diameter catalysts have a higher useful activity.



SINCLAIR
A Great Name in Oil

SINCLAIR OIL INSTALLS Its Second "Thriftiest Boiler"

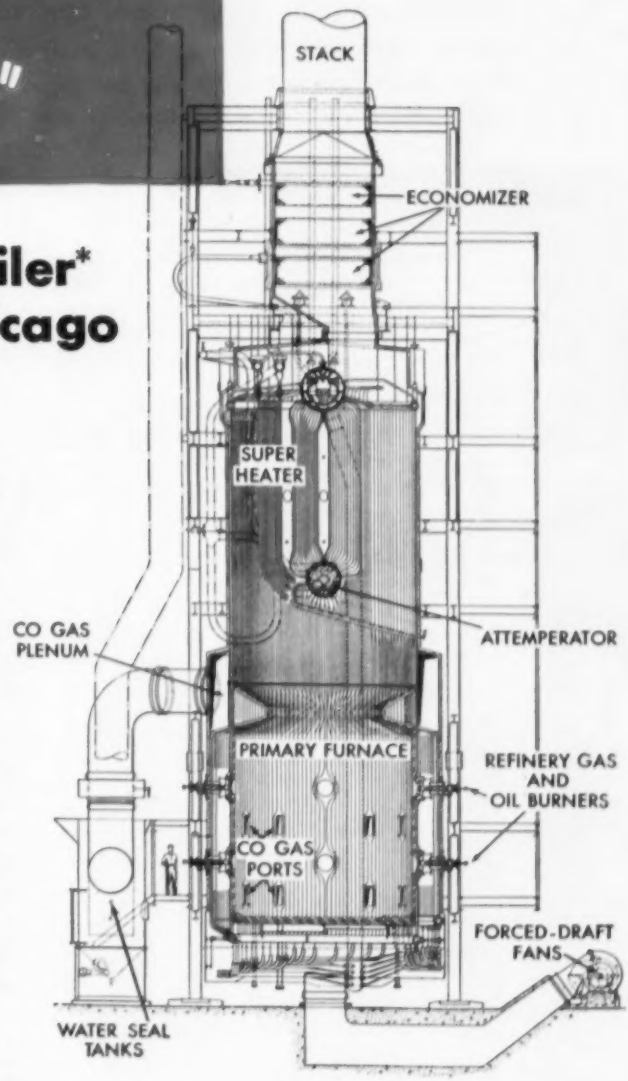
...New B&W CO Boiler* on stream at East Chicago

Recently, at the East Chicago, Indiana plant of the Sinclair Refining Company, a second B&W CO Boiler* was placed on stream. Sinclair, the originator of the CO Boiler as applied to Fluid Catalytic Cracking Units, made the first installation at its Houston, Texas refinery. As a result of the savings in fuel, Sinclair, in an advertisement, called it the "Thriftiest Boiler in the Business."

The new B&W CO Boiler for East Chicago differs from the first unit in that it has a cylindrical furnace that is surrounded by a water-cooled CO distributing chamber. Its compact design requires minimum floor space. This unit is the first of this design and promises to effect significant savings, as with the first unit. The Sinclair Refining Company is to be doubly complimented on its leadership and pioneering in turning waste gases to useful purposes.

We will be glad to furnish you with full details of the B&W CO Boiler and what it is doing for others, and can do for you. The Babcock & Wilcox Company, Boiler Division, 161 East 42nd Street, New York 17, N. Y.

***Carbon Monoxide Boiler**



BABCOCK & WILCOX

B&W BOILER DIVISION

G-743

(To obtain more data on advertised products see page 142)

HOW TO FIGURE THE COST OF STEAM TRAPS

STEAM TRAPS are something like wives. First, there is the cost of securing one and installing it in its new home. Then, there is the cost of maintaining it. Now, everyone knows that some wives are frugal and help their husbands a great deal, while others are frivolous spendthrifts. It is the same way with steam traps. You have to figure the original installed cost, the maintenance cost and the effect on general operation.

Divide the total expenses by life of the trap and you get down to the real heart of the matter—the *cost per year.* This is where Armstrong steam traps really shine! Let's take a look at the details:

DIRECT TRAP COSTS

1. First Cost. The price of Armstrong traps is low in terms of capacity. An optimum relationship between leverage, bucket weight, bucket travel and orifice size gives big capacity in a small package. Armstrong steam trap capacity ratings are based on *actual* tests with condensate at steam temperature and with actual hookups. They tell you what the trap will deliver *on the job.* This is not generally the case with other trap ratings.

2. Installation Cost. In four of the most widely used sizes, Armstrong traps are available in either side inlet—side outlet or bottom inlet—top outlet body styles, making possible the simplest, lowest cost installation.

3. Maintenance Cost. 40% less maintenance with Armstrong traps is the average of all the maintenance reduction reports secured from users over a period of years. This is due to high quality of parts, generous safety factors and inverted bucket know-how.

4. Repair Parts Cost. Armstrong heat treated chrome steel valve parts, precision ground and lapped, last a long time. When they do require renewal, a complete new valve mechanism right off the factory production line transforms an old trap into a new one at low cost.

INDIRECT COSTS

1. Cost of Steam Waste. This cost occurs through leaky trap valves, through traps that stick open or lose prime, through extra hours of operating heat transfer equipment due to poor drainage. This is a cost you can eliminate with Armstrongs.

2. Cost of Efficiency Losses. Poor trapping cuts heat transfer efficiency. Figure how much 10% loss affects the return on a $5000 production unit, or a $1,000,000 plant. Armstrong traps discharge condensate and air as fast as it accumulates, keep steam equipment at peak productive efficiency.

3. Cost of Downtime. Armstrong traps stay on the job long and faithfully, eliminating the production losses caused by excessive downtime for maintenance.

A steam trap casts a mighty big shadow that is multiplied by the number of traps in a plant until it has a major effect on operating costs. When you figure the costs from all angles you will find it pays to specify "traps shall be Armstrong."

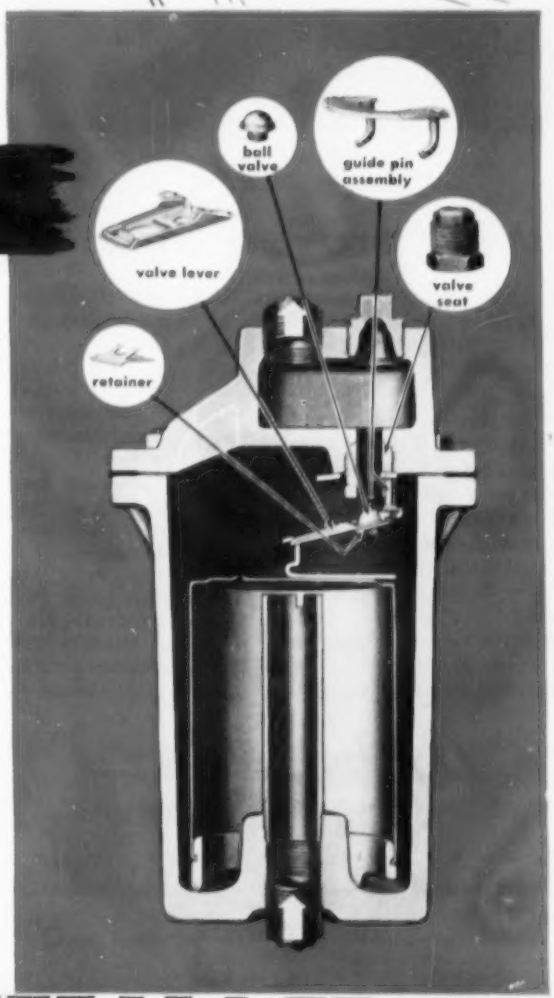
FREE: STEAM TRAP BOOK

—44 pages of prices, design, selection, installation and maintenance data on Armstrong steam traps. You are welcome to a copy. Call your local Armstrong Representative, or write.

ARMSTRONG MACHINE WORKS

826 Maple Street • Three Rivers, Michigan

YOU CANNOT BUY A BETTER TRAP THAN AN ARMSTRONG . . .

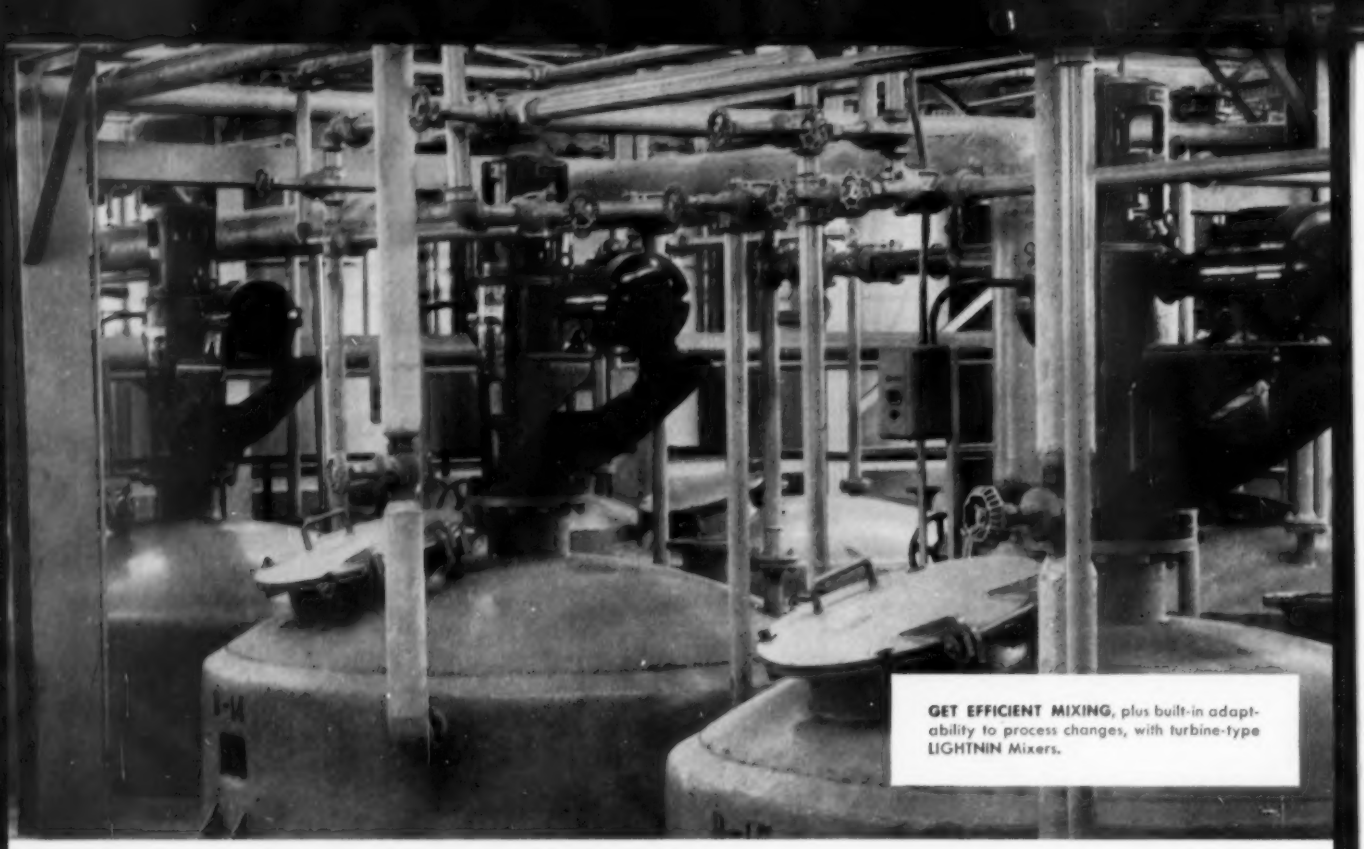


Here Are Some Questions for Cost Comparison

1. Will the valve stay steam-tight for 2 to 3, or even up to 10 years depending on the service?
2. Will the trap discharge condensate at steam temperature to keep equipment hot and minimize non-productive radiation losses?
3. Will the trap automatically discharge air in sufficient volume to keep equipment at peak temperature and to prevent corrosion?
4. Is there enough safety margin of power in the bucket and lever to open the trap when the orifice enlarges slightly due to wear?
5. Can the trap stick in open position?
6. Is the trap apt to lose prime?
7. Are the published trap capacity ratings accurate and reliable for trap selection purposes?
8. Will the trap cleanse itself of ordinary dirt and scale?
9. Is the trap easy to install, inspect and repair?
10. Is the trap unconditionally guaranteed to give complete satisfaction?

If the trap is an Armstrong, the answer to each of these questions is favorable!

ARMSTRONG STEAM TRAPS



GET EFFICIENT MIXING, plus built-in adaptability to process changes, with turbine-type LIGHTNIN Mixers.

Use this **proved method** *to get good fluid mixing*

You can't afford to *guess* about fluid mixing. And you don't need to.

On any mixing operation you can get factual answers to questions like these, to guide you in your mixer selection:

1. What precise balance of *fluid flow* and *fluid shear* will do my mixing job best?
2. If this balance can be attained in different ways, what is the *most efficient* and economical way?
3. In scaling-up, does power required per unit volume remain constant? If not, by what factor does it increase or decrease?
4. Will the mixer transmit the required power to the mix, and do it efficiently?
5. Can the mixer be installed without special construction? Can I get standard replacement parts quickly if I ever need them?
6. Am I protected against mixer obsolescence in case of a process change?

You *know* the answers to these vital questions, when you mix with LIGHTNIN Mixers.

Predicting results

Even on the simplest mixer application, your LIGHTNIN sales engineer's recommendation is based on thousands of pilot runs, plus years of in-the-field experience.

On complex mixing jobs, pilot runs at MIXCO quickly find the impeller-to-tank diameter ratio and input power that will produce the optimum fluid regime most economically. Scale-up is *guaranteed accurate.*

Mechanical economy

Your mixer investment goes into equipment that is mechanically up-to-the-minute. Hundreds of *standard* LIGHTNIN power-speed combinations (interchangeable in many models); widest possible choice of in-stock materials and interchangeable components, give you assurance of correct application, smooth running, and flexibility when you need it.

For fluid mixing that does what you want it to do, call in your LIGHTNIN Mixer representative. (He's listed in Refinery Catalog.) Or write us direct.

GET LOWEST-COST MIXING, gasoline blending, suspension of BS&W in crude, with LIGHTNIN Side Entering Mixers. New rotary mechanical shaft seal ends stuffing-box repacking forever; stops leakage; runs for years without adjustment. Yet you can replace it in minutes if ever necessary.

"Lightnin® Mixers"

MIXCO fluid mixing specialists

FOR LATEST MIXING INFORMATION and full description of LIGHTNIN Mixers, send for these helpful bulletins:

- ☐ B-102 Top or bottom entering; turbine, paddle, and propeller types: 1 to 500 HP
- ☐ B-103 Top entering; propeller types: ¼ to 3 HP
- ☐ B-108 Portable: ⅛ to 3 HP
- ☐ B-104 Side entering: 1 to 25 HP
- ☐ B-112 Laboratory and small-batch production types
- ☐ B-110 Condensed catalog showing all types
- ☐ B-111 Quick-change rotary mechanical seals for pressure and vacuum mixing
- ☐ B-107 Data sheet for figuring mixer requirements

Check, clip, and mail with your name, title, company address to:

MIXING EQUIPMENT Co., Inc., 131-d Mt. Read Blvd., Rochester 11, N. Y.

In Canada: Greey Mixing Equipment, Ltd., Toronto 10, Ont.

Petroleum Processing
APRIL 1956

How to Improve Quality by

Chemical Treatment of PETROLEUM PRODUCTS

. . . a special four-part symposium

ONE OF today's top processing problems is getting more products of higher quality out of each barrel of crude oil—upgrading the cuts obtained by normal techniques by some chemical methods such as sweetening, desulfurizing, hydroforming, removal of unsaturates, and the like.

Chemical treatment has attained considerable stature as one of the processors' trump cards for getting this wanted product quality. Up to now, however, very little up-to-date information has been published on this problem.

PETROLEUM PROCESSING'S editors are therefore especially pleased to present in the following four articles one of the most thorough and complete discussions of the "art and science" of chemical treatment it has been our good fortune to obtain.

HYDROGEN TREATING . . .

Crudes and Heavier than Gasoline Stocks,
by Jerry McAfee, Gulf Oil Corp., and W. A. Horne,
Gulf Research & Development Co. . . . . p. 47

CHEMICAL AND HYDROGEN TREATING . . .

Petroleum Fuels Heavier than Gasoline,
by W. W. Scheumann, Cities Service Research &
Development Co. . . . . p. 53

REMOVING AND CONVERTING MERCAPTANS . . .

In Gasoline and Its Components,
by H. E. Walker and E. B. Kenney, Shell Oil Co. . . . . p. 58

PRESSURE-HYDROGEN TREATING . . .

Petroleum Naphthas, by Marshall Sittig, Ethyl Corp. . . . . p. 67

Note: You may obtain reprints of this entire 24-page symposium at 75¢ each. Use the handy order form on p. 144, and circle No. R-12.

Henry G. McGrath

"An Art and a Science"

THIS symposium originated shortly after the New York A.I.Ch.E. concluded that "very little up-to-date information on the chemical treatment of petroleum fuels has been published. Specifically, it is understood that there are unreported developments in sweetening, hydroforming, desulfurization, removal of unsaturates, etc."

The four resulting articles, starting on the facing page, are thorough and cover the subject well. I want to preface them with just two points; the first, for those not completely steeped in petroleum technology; the second, for the petroleum industry veteran.

Petroleum processing is a combination of art and science. Two big advantages of petroleum over certain other fuels are: first, that it is cheap, and, second, that it is liquid.

The trouble with crude oil is nature's way of supplying it to use complete with salt, water, oxygen, sulfur, nitrogen, asphalt, and a host of metals including iron, vanadium, and nickel. Fortunately, with modern technology we can turn crude oil into a highly efficient fuel—one considerably superior to coal in hydrogen content, though still too low in hydrogen/carbon ratio.

A few pertinent techniques in this technology are:

1—Extraction with Propane and Butane. This is a process for selective removal of metals and asphalt from reduced crude by counter-current solvent extraction. One plant employing extraction with a mixture of liquid propane and butane has been in operation for nearly two years and has a capacity on the order of 30,000 b/d.

2—Coking. This process physically separates metal contaminants with the coke. Metallic compounds are ordinarily less volatile than most anything but the asphalt in the crude oil. Consequently, in the coking operation (either delayed or fluid), the bulk of the metals are removed physically with the coke.

3—Catalytic Cracking. In some instances, a significant amount of metals are present in the feed stock. They are removed by adsorption on the catalyst. In the catalytic cracking process, the backbone of the petroleum industry for so many years, metals may be removed on the catalyst which is either a porous silica-alumina material, or a Montmorillonite clay. Except in rare instances, reduced crudes cannot be charged to cracking units because of excessive catalyst poisoning.

4—Hydrogenation. This process can also remove the metal contaminants by adsorption on the catalyst. Hydrogenation of reduced crude has been offered as a solution, not only for removal of metals from reduced crude without poisoning the catalyst, but also as a means of adjusting the heating oil/gasoline ratio. Throughout the Eastern Hemisphere, the ratio of gasoline to heating oil and fuel oil is out of balance. It is far too high. Hydrogenation helps control this ratio and may solve the imbalance problem.

My second comment, for those of you well abreast of the latest petroleum developments, is prompted by the following quotation which appeared recently in an non-petroleum trade journal:

"The petroleum industry is enjoying an average year so far with an increase of only 3% over last year's total demand. But, the oil business is beset with a series of problems the like of which it has certainly never encountered before.

"A pressing problem involves the octane race which is forcing the construction of additional catalytic cracking and reforming capacity, as well as desulfurization facilities. Premium grades of gasoline are in vogue. The industry is hard pressed to meet the demand. Looming in the future is the gas-turbine engine. It may very well become standard in the 1962 automobile. Feeding on a low grade fuel such as kerosine, the gas turbine could obsolete the expensive cat cracker. Finally, there is a new source of energy in the form of nuclear fission. It is quite capable of eliminating the market for heavy types of fuel oil used by industry and the maritime services. While there are some in the petroleum industry who dismiss the importance of atomic energy, others point to the never-mentioned possibility of using heat generated in atomic reactors for industrial purposes, for direct application or for conversion to steam or electricity.

"The most woeful concept of the petroleum industry is that it will be reduced to supplying liquefied fuels as energy sources." That is one man's opinion. Mine is quite the contrary!

In conclusion, I would like to offer another quotation, this one from a book by an English pathologist.

"Elaborate apparatus plays an important part in the science and engineering of today, but I sometimes wonder if we are not inclined to forget that the most important instrument in research and development must always be the mind of man.

"It is true that much time and effort is devoted to training and equipping the scientist's or engineer's mind, but little attention is paid to the technicalities of making the best use of it."

The processes and techniques that are discussed in the four articles that follow had their origin in the mind of man. Each of them required considerable inventiveness, initiative, and hard work to put them across.

Mr. Henry G. McGrath

. . . is Associate Manager of the Business Development Department of the M. W. Kellogg Co. He organized this symposium—"Chemical Treating of Petroleum Fuels" (which starts on the facing page)—for the 1955 All-Day Symposium of the New York Section of the American Institute of Chemical Engineers. It was presented in New York on Oct. 20, under Mr. McGrath's chairmanship.

He received his B.S. in Chemical Engineering from Massachusetts Institute of Technology (1936) and his M.S. in Chemical Engineering Practice from M.I.T. (1937), after which he joined the Kellogg Co. For several years he was Associate Director of Research. In 1954 he became Associate Manager of the company's newly formed Business Development Department.

Mr. McGrath is the author of many technical papers on petroleum processing and chemical production. He holds about 30 U.S. patents in these fields.

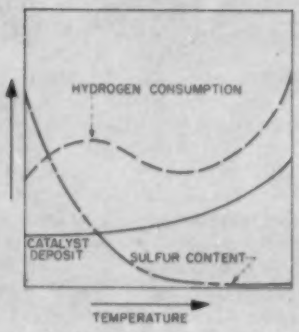


Fig. 1—**TEMPERATURE** effect in hydrogen treating

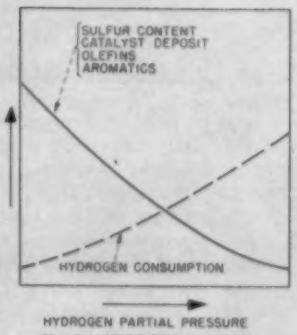


Fig. 2—**HYDROGEN** partial pressure effect

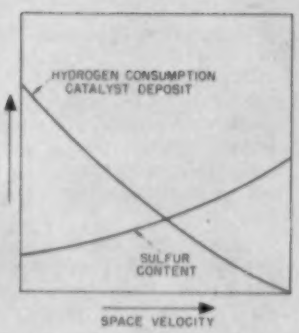


Fig. 3—**SPACE VELOCITY** effect in hydrogen treating

1 2 3 4

Crudes and Heavier-than-Gasoline Stocks

Hydrogen Treating

By JERRY McAFEE, Gulf Oil Corp., and

W. A. HORNE, Gulf Research & Development Co.

THE availability of relatively cheap by-product hydrogen from catalytic reforming has focussed attention on the hydrogenation of whole crude oil and intermediate distillate and residual fractions. This article presents typical results that can be obtained when processing various stocks at commercially feasible conditions.

The improvements that can be realized in hydrogen treating furnace oil distillates are primarily a reduction in sulfur content and a marked enhancement of stability characteristics. Cracking stocks are made more susceptible to subsequent catalytic cracking, and the quality of the catalytically cracked products obtained from them is improved. Hydrogen treatment of lubricating oil stocks results in better color, carbon residue, and stability.

Processing of whole crudes and residues in the presence of hydrogen and suitable catalysts accomplishes an upgrading of the heaviest portion of the stock into lighter materials, with moderate coke production, and simultaneously desulfurizes all resulting fractions to a very considerable degree.

Hydrogen treating or hydrogenation of petroleum stocks is not new to the petroleum industry. A great deal of exploratory and pilot plant research has been carried out over the last twenty-five years, investigating the utility and versatility of hydrogen as a treating agent and its possible application to the manufacture of fuels and lubricants.

Although many applications appeared promising, the expensive necessity of manufacturing the required hydrogen deferred most commercial installations. However, the advent of catalytic reforming, which produced the desired hydrogen as a refinery by-product, now makes attractive the commercial development of hydrogen treating processes.

The phenomenal growth of catalytic reforming, which has been spurred on by the demand for ever-increasing octane quality of automotive gasoline, has given no indication of slackening. Recent compilations show that there is presently installed 885,700 b/d of operating capacity with 344,700 b/d of additional capacity under construction or planned. Some predictions indicate that this growth will continue, and a forecast of 2,500,000 b/d by 1965 has been made.[1]

As the octane requirement of automotive engines continues to rise, the catalytic reforming operations will become more severe, and the quality of charge stocks is likely to decline. Although these two factors will result in lower purity hydrogen, it will be available in ever-increasing quantities.

The hydrogen potentially available is tremendous. The amount calculated to be immediately available from the above-cited reforming capacity is approximately ½ billion cu.ft./day, rising to approximately 1.5 billion cu.ft./day by 1965.

Because of the almost unequaled quality improvements which can be brought about by hydrogen treatment, a large number of refiners are utilizing or planning to utilize their available hydrogen for upgrading refinery stocks.

Although some refiners have considered it expedient to use their by-product hydrogen as a raw material for the manufacture of ammonia, it has been predicted that the refinery use of hydrogen will become so great that some companies will require more hydrogen than available to them from catalytic reforming.

Although the availability of hydrogen from catalytic reforming is the dominant factor in the recent activity in hydrogen treating, there are a number of other contributing factors.

Customer demands have dictated improvements in all petroleum products, and this at a time when higher and higher percentages of lower quality crudes are produced and processed.

It is propitious that hydrogen has become available at the same time that the quantity of high-sulfur heavy crudes being processed has markedly increased. Hydrogen treating can upgrade these crudes and fractions to the quality of sweet, low-sulfur crudes.

In addition to the press of ever-

The introductory remarks and four articles in this symposium on "Chemical Treating of Petroleum Fuels" were presented at the New York Section of the American Institute of Chemical Engineers, New York City, Oct. 20, 1955.

increasing product quality, the mounting municipal legislation governing smoke control and air pollution is a cogent incentive toward reducing the sulfur content and improving the burning characteristics of all grades of fuel oil.

A great deal has been published in the last several years about a wide variety of hydrogen treating processes.[2] These processes, some of which are commercial, all utilize hydrogen as a means of improving the quality of various fractions of petroleum or intermediate process streams.

In the following sections of this article, the principal effects of hydrogen in the upgrading of middle distillates, cracking stocks, lubricating oil stocks, residuals, and whole crudes are summarized briefly.

Table 1—Range of operating conditions for hydrogen treating

Temperature, °F.	500-800
Pressure, psig	100-1000
Space velocity, v/h/v	0.5-20.0
Hydrogen concentration in recycle, vol. %	20-90
Recycle gas rate, SCF/bbl.	400-4000
Time between regeneration, days	<1->365

General Considerations

The application of a hydrogen treating process to specific charge stocks will be considered in later sections of this article. First, consider the general effects produced by the principal reaction variables.

The principal effects of temperature are shown in Fig. 1. As the temperature is increased, the sulfur content of the treated stream decreases. The hydrogen consumption increases to a maximum, and then it declines because of the incidence of dehydrogenation reactions and ultimately rises again to an extremely high value as the temperature is increased into the wild hydrocracking range with attendant loss of liquid yield.

The catalyst deposit increases as the temperature increases; hence, the temperature should be maintained as low as possible, consistent with the desired degree of upgrading so that the rate of catalyst fouling is minimized.

Hydrogen partial pressure effect is shown in Fig. 2, made up of the combined effects of total pressure, hydrogen concentration of the recycle gas, and the recycle gas to oil ratio.

As the hydrogen partial pressure increases, the more complete is the removal of sulfur, the saturation of olefins, and the conversion of aromatics to naphthenes.

Also the deposit of coke on the catalyst is suppressed by the higher hydrogen partial pressure. All of these desirable effects are at the expense of increased hydrogen consumption.

The third major variable, space velocity, or the amount of charge per unit catalyst per unit time, has an effect as shown in Fig. 3.

As the space velocity is increased, the sulfur removal reactions, as well as all other catalytic and thermal reactions involved, becomes less. Naturally the hydrogen consumption and formation of carbon deposit on the catalyst also decrease. The changes which take place in any specific charge stock by hydrogen treating are a complex function of these variables.

The necessary operating conditions can be set only after taking into consideration the charge stock and the extent of improvement desired; however, Table 1 shows the general range of operating conditions which apply to almost any stock which might be processed.

The basic plant required for hydrogen treating is essentially the same regardless of the stock processed.

The simplified flow diagram for hydrogen treating of middle distillates illustrates the principal processing units required.

The fresh feed is preheated with hydrogen and passed through a multiple-bed reactor containing the catalyst. Hydrogen or oil quench may be injected between the catalyst beds to remove the exothermic heat of reaction and control the reaction temperature.

The reactor effluent is cooled, and the recycle gas is separated from the liquid phase. For middle distillates, this liquid product is stripped of gasoline to obtain the desired treated product, and the small amount of gasoline is stabilized to remove the hydrogen sulfide, which in turn is burned or charged to a sulfur recovery plant.

Table 2—Hydrogen treating of Kuwait furnace oil distillates
(Typical product inspection)

Inspection data	FCC Furnace Oil		Straight-Run Furnace Oil	
	Untreated	Treated	Untreated	Treated
Gravity, °API	23.0	26.8	38.9	40.4
Color, ASTM Union	2	2–	1–	1–
Doctor	Sour	Sweet	Sour	Sweet
Sulfur, %	2.52	0.50	1.13	0.33
Mercaptan sulfur, %	0.003	0.001	0.021	0.001
Carbon residue, Conradson on 10% bottoms, %	0.36	0.07	0.03	0.03
Neutralization No.	0.03	0.01	0.04	0.01
Bromine No.	32.3	13.9	7.4	4.3
Aniline Point, °F.	80.9	88.6	155.5	157.8
Cetane Index	27.8	33.5	55.7	58.1
Stability, 210°F., 16 hr.				
Insoluble sludge, mg/600 g.	4.2	1.0	0.5	0.1
Color, ASTM Union	4½–	2½–	1–	1–
Distillation				
Over point, °F.	434	395	366	359
End, °F.	642	640	643	636
10% at, °F.	481	463	427	433
50% at, °F.	533	523	507	502
90% at, °F.	603	606	599	596

Table 3—Accelerated storage stability of hydrogen-treated furnace oil distillates

	Initial		After 16 hrs. at 210°F.		
	Color Union	Carbon residue on 10% bottoms	Insolubles, mg/600 g.	Filtrate color, Union	Carbon residue on 10% bottoms
Light catalytic cycle oil					
Untreated	2.0	0.11	90	8+	0.19
Hydrogen treated	2.0	0.05	1	2.5	0.09
West Texas straight-run					
Untreated	1.0	0.02	4	1.5	——
Doctor sweetened	1.0	0.25	12	1.5	0.27
Hydrogen treated	1.0	0.01	1	1.0	0.01

Middle Distillates

With the exception of catalytic reformer feed stock preparation, the hydrogen treatment of middle distillates is currently the largest application of this type of processing.

The primary objective in hydrogen treating of diesel oils and heating oils is to enhance their quality by a reduction in sulfur and carbon residue content and an improvement in burning characteristics, color stability, and resistance to sludging.

Typical product inspections from hydrogen treating of both fluid-cracked and straight-run Kuwait Furnace Oil Distillates are shown in Table 2. These products are considered typical and illustrate the improvements by hydrogen treating.

The gravity in general increases 1°API to 4°API, with severe processing conditions on the cracked stocks giving the greatest increase.

When freshly prepared distillates are processed, the color of the product is usually the same as or slightly better than the charge stock.

The Doctor test result is sweet, and the extent of desulfurization is normally 70% to 90%, with mercaptans being completely removed.

Carbon residue on the 10% bottoms is decreased to less than 0.10%. Neutralization number is reduced to 0.01% or less on both straight-run and cracked stocks.

While some of the olefins are saturated, there is essentially no change in the content of aromatics. The Cetane Index undergoes an increase from one to five numbers.

The accelerated stability shows that products from hydrogen treating are of excellent quality with respect to both a change in color and in sludge formation during storage. This improved stability is more clearly illustrated in Table 3 where the accelerated storage stability of light catalytic gas oil and that of West Texas straight-run furnace oil distillate are shown.

Color increase on aging is much greater for the untreated distillate than for the hydrogen treated distillate. The carbon residue on the 10% bottoms of the filtrate from both cracked and straight-run stocks is greatly reduced.

A much improved stability and a much lower carbon residue result from hydrogen treating of the West Texas distillate than by Doctor sweetening.

Cat Cracking Charge Stocks

The improvement of the cracking characteristics of catalytic charge stocks is another application of hydrogen treating. Although virgin cracking stocks are quite susceptible to improvement, the catalytic gas oil recycle streams are of lower quality and hence subject to greater improvement.

A 19.3°API catalytic gas oil which contained considerably more furnace oil boiling range material than is normally present in a heavy catalytic gas oil was hydrogen treated, and the yields and inspection data obtained are summarized in Table 4.

With this charge stock, a gravity increase of 4.1°API and a sulfur re-

Table 4—Hydrogen treating of heavy catalytic gas oil

Yields, vol.% of liquid charge	Charge	Product
Depropanized gasoline	—	0.3
Gas oil	—	101.0
Total	—	101.3
H_2S, SCF/bbl.	—	72
Gas (C_3 and lighter), SCF/bbl.	—	65
Gas (C_3 and lighter), % by vol. FOE	—	1.1
Hydrogen Consumption, SCF/bbl.	—	408
Desulfurization, %	—	82.4
Inspection data, gas oil		
Gravity, °API	19.3	23.4
Sulfur, %	2.25	0.40
Carbon residue, Conradson, %	0.06	0.02
Bromine No.	21.4	13.5
Characterization Factor, K	11.03	11.24
Distillation, vacuum corrected to 760 mm Hg		
Over point, °F.	363	306
10% at, °F.	567	532
30% at, °F.	619	592
50% at, °F.	650	630
70% at, °F.	678	669
90% at, °F.	723	720

Table 5—Effect of hydrogen treating on cracking characteristics of heavy catalytic gas oil from cracking virgin Kuwait gas oil

(Basis: Constant conversion of 31.0% by volume)

Charge Stock	Untreated heavy catalytic gas oil	Hydrogen treated heavy catalytic gas oil
Yields, vol. % of fresh feed		
Depropanized gasoline distillate	23.5	27.5
Butane-butene	5.2	5.9
Debutanized gasoline distillate	18.3	21.6
Propane-propylene	4.0	4.0
Light catalytic gas oil	30.4	35.4
Heavy catalytic gas oil	38.6	33.6
Total	96.5	100.5
Gas (C_3 and lighter), wt.%	2.2	1.6
Coke, wt.%	6.6	3.2
Inspection data		
Stabilized gasoline distillate		
Sulfur, L: %	0.14	0.02
Bromine No.	104	88
Knock ratings (Adjusted to a 10 RVP)		
Motor, clear	80.2	81.7
Motor, + 3cc TEL	82.6	85.4
Research, clear	92.2	95.0
Research, + 3cc TEL	95.6	100.2

Table 6—Effect of hydrogen treating on cracking characteristics of heavy catalytic gas oil from cracking virgin Kuwait gas oil

(Basis: Constant coke yield, 6.6 wt.% of fresh feed)

Charge Stock	Untreated heavy catalytic gas oil	Hydrogen treated heavy catalytic gas oil
Gas Oil Conversion, vol.% of fresh feed	31.0	43.6
Yields, vol.% of fresh feed		
Depropanized gasoline distillate	23.5	34.9
Butane-butene	5.2	8.9
Debutanized gasoline distillate	18.3	26.0
Propane-propylene	4.0	6.0
Light catalytic gas oil	30.4	31.7
Heavy catalytic gas oil	38.6	24.7
Total	96.5	97.3
Gas (C_3 and lighter), wt.%	2.2	3.1
Coke, wt.%	6.6	6.6
Inspection data		
Stabilized gasoline distillate		
Sulfur L: %	0.14	0.02
Bromine No.	104	78
Knock ratings (Adjusted to a 10 RVP)		
Motor, clear	80.2	82.5
Motor, + 3cc TEL	82.6	86.0
Research, clear	92.2	95.3
Research, + 3cc TEL	95.6	101.0

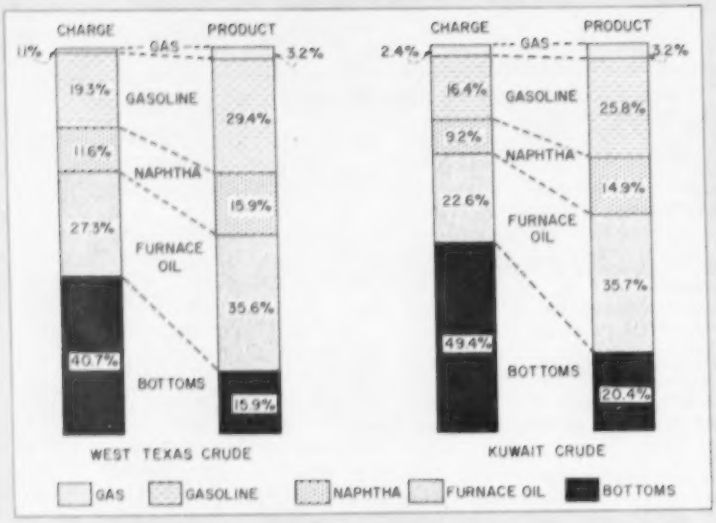


Fig. 4—**TYPICAL HDS RESULTS** with West Texas and Kuwait crudes

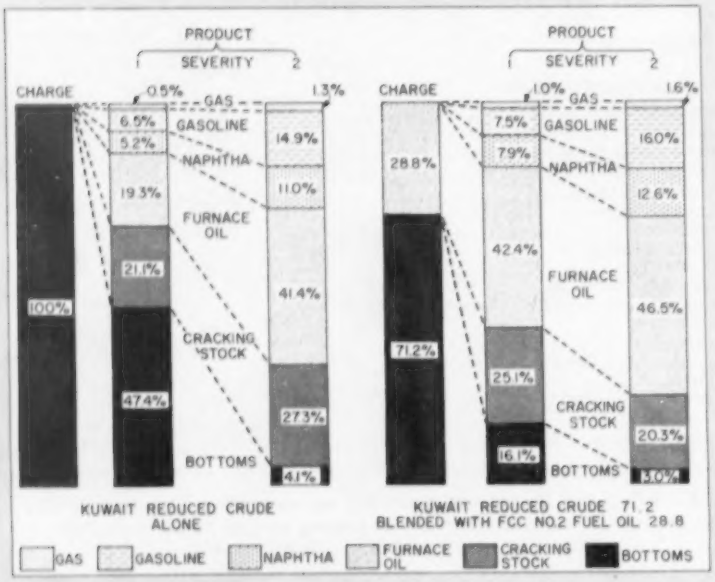


Fig. 5—**TYPICAL HDS RESULTS** with Kuwait reduced crude

Table 7—Hydrogen treating of lubricating oil stocks

	Unfiltered neutral distillate		Unfiltered bright stock	
Inspection data	**Charge**	**Product**	**Charge**	**Product**
Viscosity, SUS at:				
100°F.	471	451	2768	2070
210°F.	61.9	61.0	161	137
Viscosity index	97	98	96	98
Pour point, °F.	−5	+5	−5	−5
Carbon residue	0.03	0.01	1.05	0.25
Color, ASTM Union	3.25	0.75	4.25(dil.)	4.25
Iodine No.	4.7	2.8	11.5	8.6
Sulfur, %	0.19	0.11	0.33	0.09
Neutralization No.	——	——	0.09	0.01

moval of 82.4% was obtained. The characterization factor was increased approximately 0.2.

In this case, hydrogenation caused a significant decrease in the boiling range of the heavy catalytic gas oil. The 10% point of the charge stock was 567°F., and the 10% point of the product was 532°F. About 9% of material lighter than the charge stock was produced by hydrogenation. This material was quite aromatic (21.4°API and 10.66 characterization factor) with an extremely low-sulfur content (0.09%).

The cracking characterictics of the untreated and the hydrogenated heavy catalytic gas oils with SR Filtrol catalyst at a converison of 31% are compared in Table 5. This table shows the charge stock inspection, product yields, and stabilized gasoline distillate inspection.

Hydrogenation resulted in a significant reduction (52%) in the yield of carbon and an increase in the yield of gasoline and light catalytic gas oil of 17% and 16% respectively.

A comparison of the data in Table 6 on the untreated and hydrogenated stock at a constant coke yield of 6.6% shows that a 12.6% on charge higher conversion and about a 50% greater yield of depropanized gasoline was obtained when cracking the hydrogenated stock.

The inspection data on the gasoline from the cracking shows that hydrogen treating caused a significant improvement in the quality. The gasolines produced from the hydrogenated stock had Research octane numbers of about 95 clear and 100-101 with 3cc. TEL, whereas the gasoline produced from the untreated stock had an unleaded Research number of 92.2 and leaded Research octane number of 95.6.

In addition, the gasolines obtained from the hydrogenated stocks had extremely low-gum content and high-oxidation stabilities. Thus, both the improved yields and product quality demonstrate the desirability of hydrogenating catalytic recycle stocks prior to catalytic cracking.

Lubricating Oil Stocks

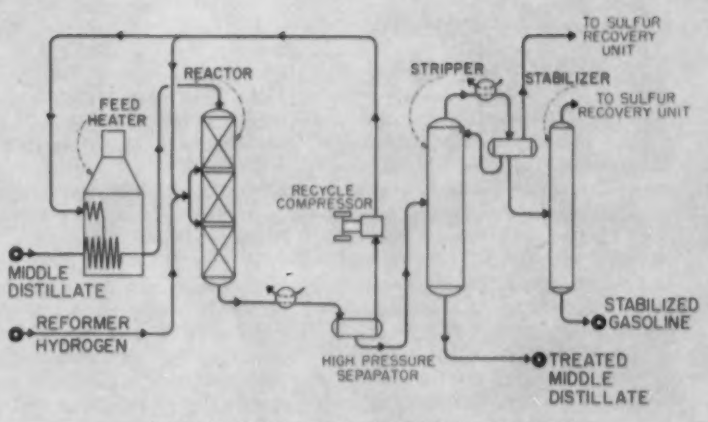
Another petroleum fraction which can be significantly improved by hydrogen treating is lubricating oil stock.

Typical results obtained when hydrogen treating an unfiltered neutral distillate and an unfiltered bright stock are shown in Table 7.

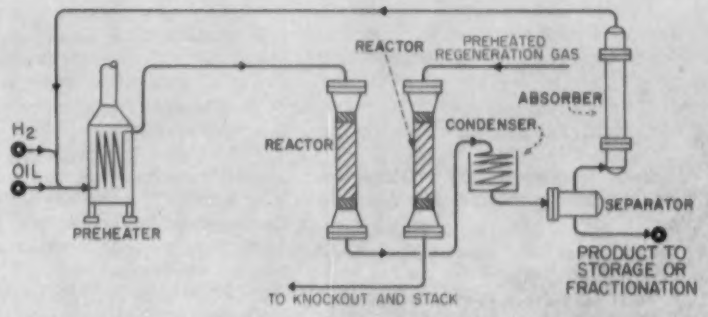
The principal advantages apparent from the hydrogen treatment are the marked improvement in color and the reduction in carbon residue and sulfur

Table 8—Typical results of HDS processing of Kuwait crude

Data on charge and total liquid product	Crude Charge	HDS Product
Yield, vol.%	——	96.0
Desulfurization, %	——	82.5
Gravity, °API	30.8	42.4
Sulfur, %	2.61	0.46
Carbon residue, %	5.3	0.06
Fractionation of charge and product		
Gas, C_2 & C_3, vol.%	2.4	3.2
Debutanized, 300°F E.P. gasoline		
Yield, vol.%	16.4	25.8
Gravity, °API	70.3	68.9
Sulfur, %	0.04	0.03
Motor octane, clear	47.2	53.9
Naphtha, 300-410°F		
Yield, vol.%	9.2	14.9
Gravity, °API	50.5	47.8
Sulfur, %	0.16	0.05
Motor octane, clear	23.4	39.8
Furnace oil, 410-670°F		
Yield, vol.%	22.6	35.7
Gravity, °API	37.3	34.3
Sulfur, %	1.21	0.47
Bottoms, 670°F and heavier		
Yield, vol.%	49.4	20.4
Gravity, °API	14.4	20.9
Sulfur, %	4.11	0.84
Carbon residue, %	9.8	0.88
Hydrogen consumption, scf/bbl. charge	——	499
HDS yields, wt.% of charge	——	99.72
Dry gas	——	4.65
Depropanized liquid product	——	89.63
Catalyst carbon	——	3.29
Sulfur removed	——	2.15



MIDDLE DISTILLATE HYDROGEN TREATING



GULF HDS PILOT PLANT

content which result from hydrogenation of asphaltenes and desulfurization of the lubricating oil stocks.

In addition, the oxygen content is reduced as shown by the decrease and almost complete elimination of acidic compounds, i.e., neutralization number.

There is little change in the hydrocarbon character except for a moderate hydrogenation of unstable bonds, which decreases the Iodine No. and results in an increase in the resistance of the oil to oxidation.

The decomposition reactions taking place lead to a lowering of the viscosity and in more severe processing to some hydrocracking which yields lower boiling hydrocarbon products. A combination of these effects results in a slight improvement in the Viscosity Index .

Thus, raw neutral distillates as well as bright stocks are hydrogenated to produce higher quality blending stocks for the preparation of stable automotive oils. Other types of lubricants, such as turbine and transformer oils can also be markedly improved by hydrogenation.

Crudes and Residuals

Although sulfur removal and other quality improvements in distillates are desirable and sometime necessary, hydrogenation of the heaviest portions of crude oil offers a much greater incentive from an economic standpoint.

In addition, as previously pointed out, an improvement in the quality of residual fuel oil may be forced upon refiners by various pressures to alleviate the smoke and smog problem which exists in certain areas.

One means of upgrading the quality of crude oils and residual stocks is the recently described moderate pressure Gulf HDS Process[3]. This process converts heavy residual fractions to lower boiling distillate products while simultaneously effecting a substantial degree of desulfurization.

A simplified flow sheet of the 50 b/d, HDS pilot plant used in the development of this process is shown.

Oil and hydrogen are preheated and enter the top of one of two reactors containing the catalyst and in which conversion takes place.

Reactor effluent is condensed and cooled and flows to a high-pressure separator. Gas from this separator passes through an absorber for hydrogen enrichment and is then recycled to the inlet of the heater.

Liquid product either is sent directly to storage or is subjected to further fractionation.

While one reactor is being used for processing, the other is regenerated by means of flue gas or steam to which air is added in controlled amounts.

Typical results which have been obtained in processing two charge stocks on this unit are shown on Tables 8 and 9.

Table 8 gives the over-all results obtained from processing whole, desalted Kuwait crude. A product having a gravity of 42.4°API, a sulfur content of 0.46%, and a carbon residue of 0.06% was obtained at a yield of 89.6 wt.% from a charge stock having a gravity of 30.8°API, a sulfur of 2.61% and a carbon residue of 5.30%.

Catalyst carbon amounted to 3.3 wt.%, gas production was 4.7 wt.%, while 2.1 wt.% of surfur was removed, giving an over-all desulfuriza-

tion of 82%. The hydrogen consumption was 499 SCF/B.

A breakdown of the desulfurized product in comparison with a similar fractionation of the charge stock shows that there has been a substantial increase in the amount of gasoline, naphtha, and furnace oil in the charge at the expense of the residuum, and each of these lighter fractions has been desulfurized to a considerable extent.

The residual fraction, in addition to being reduced in yield from 49.4% to 20.4% has also had is sulfur content reduced by about 80%, and at the same time, the carbon residue has been reduced from 9.8% to 0.88%.

Product and charge stock fractionation data for Kuwait crude, as well as for West Texas Crude, are presented graphically in Fig. 4, in which the very considerable reduction in bottoms yield with a corresponding increase in the production of gasoline, naphtha, and furnace oil is evident.

In Table 9 typical results from HDS processing of 17% vacuum bottoms from Kuwait crude are given at two levels of severity.

This very heavy charge stock has been substantially upgraded and simultaneously desulfurized. As would be expected, the catalyst coke laydown and the hydrogen consumption are both somewhat higher than previously shown for whole crude and increase with increased severity.

Fractionation of the product for these runs shows that the reduced crude has been converted in the first case to about 53% and in the second to almost 96% of light products, the extent of conversion and the degree of desulfurization both increasing with increased severity.

The degree of upgrading of the Kuwait reduced crude can be clearly seen in Fig. 5 in which the product fractionation from the two reduced crude runs, as well as two runs on a reduced crude-cracked No. 2 fuel oil blend, are shown graphically.

The increased refinery runs of heavy high-sulfur stocks has already forced many petroleum refiners to apply hydrogen treating to product streams in order to maintain product quality. In addition, a continuation of the trend to improve the quality of finished products is necessary to meet customer demand.

However, the increased yield of residual fuels from low-grade stocks and the reduced percentage demand for these heavy residual fuels has spotlighted the essential incentive for hydrogenation, the conversion of low-grade crudes and residuals into distillates.

Table 9—Results of HDS processing of Kuwait reduced crude

Data on charge and total liquid product	Reduced Crude Charge	HDS Product Severity 1	HDS Product Severity 2
Yield, vol.%	——	101.8	99.3
Desulfurization, %	——	69.9	92.5
Gravity, °API	5.8	20.8	33.2
Sulfur, %	5.45	1.64	0.41
Carbon residue, %	19.8	8.43	1.09
Fraction of charge and product			
Gas, C_3 & C_4, vol.%	——	0.5	1.3
Debutanized, 300°F E.P. gasoline			
Yield, vol.%	——	6.5	14.9
Sulfur, %	——	0.17	0.1
Motor octane, clear	——	54.0	50.5
Naphtha, 300-410°F			
Yield, vol.%	——	5.2	11.0
Sulfur, %	——	0.11	0.03
Motor octane, clear	——	46.4	46.5
Furnace oil, 410-670°F			
Yield, vol.%	——	19.3	41.4
Gravity, °API	——	30.8	32.3
Sulfur, %	——	0.54	0.16
Cetane No.	——	45	44
Cracking stock, 670°F to	——	925°F	950°F
Yield, vol.%	——	21.1	27.3
Gravity, °API	——	21.3	20.8
Sulfur, %	——	0.93	0.42
Carbon residue, %	——	0.21	0.59
Bottoms			
Yield, vol.%	100.0	47.4	4.1
Gravity, °API	5.8	9.6	2.1
Sulfur, %	5.45	2.40	3.72
Carbon residue, %	19.8	19.4	32.9
Hydrogen consumption, scf/bbl. charge	——	650	1140
HDS yields, wt.% of charge	——	99.4	100.6
Dry gas	——	1.5	6.4
Depropanized liquid product	——	91.7	82.7
Catalyst carbon	——	2.4	6.4
Sulfur removed	——	3.8	5.1

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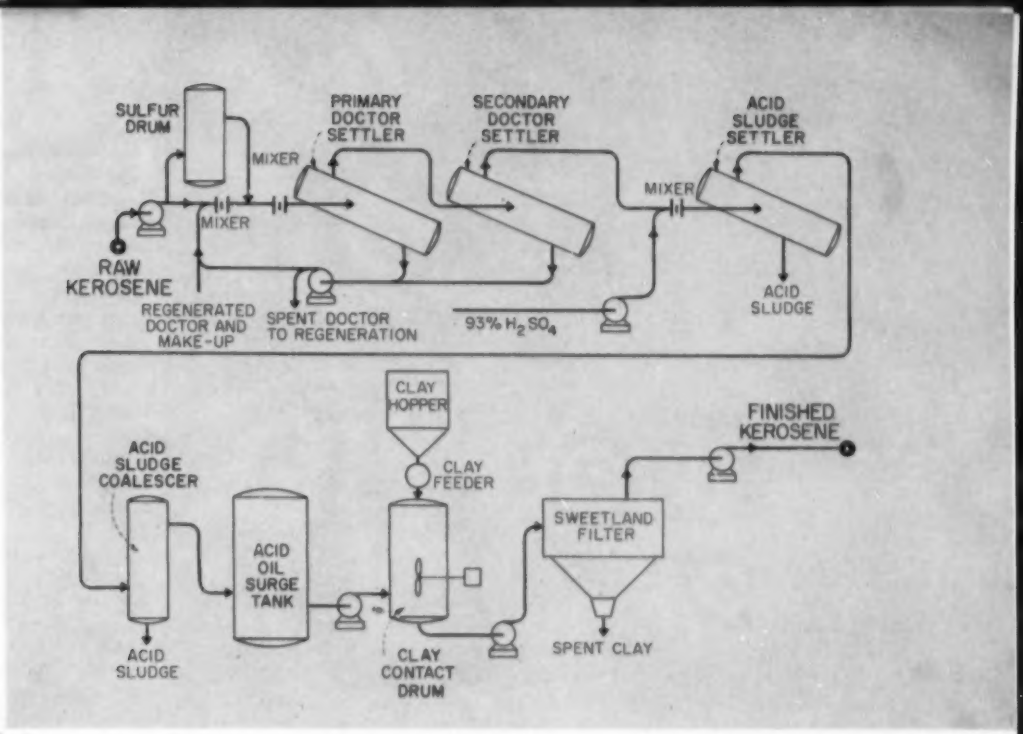

Fig. 1—**DOCTOR-ACID-CLAY TREATING** of kerosene to remove mercaptans

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13

Petroleum Fuels Heavier than Gasoline

Chemical and Hydrogen Treating

By W.W. SCHEUMANN, Cities Service Research & Development Co.

FIVE major factors have tended to increase attention given to middle-distillate finishing in recent years. They are:

1—The rapid growth in the use of catalytic cracking has greatly reduced the volume of straight-run distillates heavier than kerosene which are available for sales as fuels.

Catalytic cracking is preferentially carried out on virgin feed stocks and as a result, today large volumes of catalytically and thermally cracked cycle gas oils are sold as heating oil and diesel fuel.

2—In order to obtain the necessary volumes of feed stocks, the refiner has found it necessary to dig much deeper into the crude barrel. In the eight-year period from 1946 through 1955 the average yield of residual fuel in the U.S. refineries has dropped from 24.9% to an estimated 15% per barrel of crude.

This has been accomplished through the application of vacuum distillation, deasphalting, vis-breaking, coking and other processes. The distillate products from these processes contain more sulfur than the lighter distillates from the same crude. Consequently, the catalytically cracked cycle oils obtained from these feeds have a higher sulfur content.

3—The rapidly increasing demand for middle-distillate fuels prevents the refiner from picking and choosing. Every barrel available of the proper boiling range, regardless of quality, must be finished into marketable fuels.

4—Lower grades of crude oil, characterized by lower gravity and higher sulfur, nitrogen and metal contents, are being used in greater quantities than before.

5—There is the increasing emphasis upon product-quality improvement in the highly competitive petroleum market. Now the refiner must finish these lower quality intermediates into even better finished products.

The subject of finishing middle-distillates is so broad that it has been necessary to keep this discussion very general in nature. The finishing of kerosene, dometsic heating oils, light diesel fuels and jet fuels will be discussed.

In the case of kerosene and domestic heating oils, one or more of the treating methods used for good, medium and low quality raw stocks will be covered.

Since the finishing methods used on diesel fuels and jet fuels closely parallel those used on domestic heating oil and kerosene respectively, only the problems peculiar to these products will be mentioned.

For the convenience of those desiring more detailed information, references are listed at the end of this article.

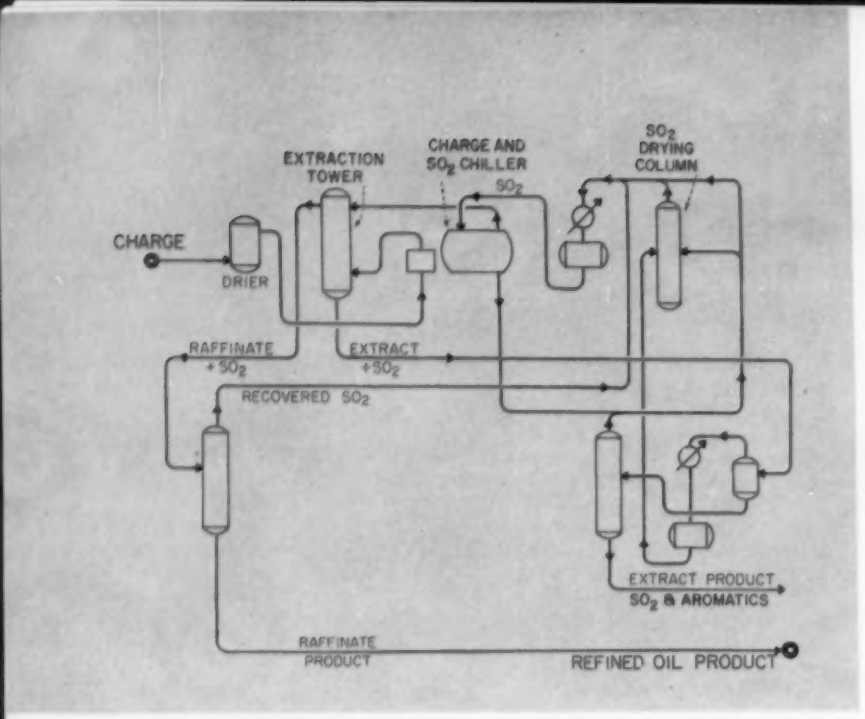


Fig. 2—**SO_2 EXTRACTION** of kerosene to remove mercaptans and aromatics

Kerosene

Since kerosenes are often handled by the ultimate consumer, they must have a minimum of odor, must be colorless, and have a bright appearance. Also, kerosene must burn in wick feed burners without charring or building up deposits on the wick. The flame produced by the kerosene must be smoke free.

In many space heating applications such as incubators and brooders, it is essential that the flame remain constant for relatively long periods without adjustment.

The principal contributors to poor kerosene quality are aromatic hydrocarbons and compounds of sulfur and nitrogen. Aromatic hydrocarbons adversely affect the burning characteristics of the fuel by increasing the tendency to smoke and to build up deposits.

Sulfur and nitrogen compounds impart objectionable odors to the raw distillate. They also contribute to color instability and possibly wick deposits. Free sulfur in the oil renders it corrosive to copper.

The burning characteristics of kerosenes are usually controlled by selecting kerosene fractions which have low aromatic contents, but treating methods are available which will produce satisfactory products from inferior stocks.

Sulfur compounds are either removed or converted into less objectionable types of chemical treatment.

When nitrogen compounds are present in appreciable amounts in the raw kerosene, treatment for their removal is used.

The selection of a finishing process for kerosene is naturally dependent on the type of stock available and the quality level desired on the finished product, in addition to economic considerations.

Good Quality Raw Stock

Frequently, kerosenes yielded from highly paraffinic, low sulfur crudes such as Pennsylvania and many Mid-Continent crudes need no treatment other than sweetening; that is, conversion of the malodorous mercaptans into odorless disulfides.

Plumbite treatment, commonly referred to as Doctor sweetening,[1,2] is the most widely used of all the chemical processes developed to convert mercaptans into disulfides.

The chemicals used in this treatment are alkaline sodium plumbite and elemental sulfur. Sodium plumbite, the so-called "doctor" solution, is prepared by dissolving litharge in caustic soda.

Finished plumbite solution generally contains about 3½% litharge in 18° Bé caustic (13%). While the actual concentration of plumbite is not critical, a large excess of caustic soda is always employed since it helps to keep the lead in solution and is effective in bringing the mercaptans and the reagent into contact. Also, it plays an important part in the regeneration of the spent reagent which will be discussed later.

In the sweetening operation, the kerosene is agitated, in either batch or continuous equipment, with alkaline sodium plumbite solution and a controlled amount of sulfur. In this treatment the mercaptans are oxidized to disulfides, with the preciptation of an equivalent amount of lead sulfide.

Upon settling, the lead sulfide and partially spent plumbite solution separate, and the latter is either recirculated or withdrawn for regeneration. One of the more common methods of regeneration is oxidation of the lead sulfide as a caustic slurry by heating to about 175°F and blowing with air, which reconverts the sulfide to plumbite.

In this treatment, the disulfides formed remain in the kerosene, and no reduction in sulfur content is obtained. Care must be exercised to add only the amount of sulfur required to convert the lead mercaptides to disulfides and lead sulfide. Too much sulfur will render the finished kerosene corrosive to copper and other metals.

Medium Quality Raw Stocks

Kerosenes yielded from crudes which are not as paraffinic and which contain more sulfur usually require additional treatment to improve color stability and burning characteristics.

One chemical treating process which has been used successfully to finish kerosene yielded from selected low sulfur, Mid-Continent crudes is shown in Fig. 1.

The first step in this process is doctor treatment followed by contacting with 93% sulfuric acid. After careful removal of the sludge formed by the acid treatment, the kerosene is contacted with 200-300 mesh fuller's earth which is removed from the kerosene in a Sweetland filter.

When kerosene produced from selected crudes in modern distillation equipment is treated in this manner, the finished kerosene has satisfactory burning characteristics and storage stability.

Low Quality Raw Stocks

Some refiners are confronted with the problem of making kerosene from middle-distillate fractions having high aromatic and/or high sulfur contents.

Heavy sulfuric acid treatment, followed by neutralization and redistillation can in some cases produce satisfactory kerosenes from these stocks. However, the losses incurred by this method of treatment are excessive, and sludge disposal is troublesome.

A selective solvent, which preferentially removes aromatic and sulfur

containing constituents, is a more effective treating method.

Liquid sulfur dioxide is one of the most effective solvents of this type. Fig. 2 illustrates the flow in a typical SO_2 extraction unit.

Kerosene charge is pumped through a coalescer for the removal of free water and then through a dryer. It is next cooled by heat exchangers with raffinate solution and chilled to final temperature by refrigeration with SO_2. Chilled kerosene is then introduced in the lower section of the extraction tower.

In the extraction tower, the kerosene is contacted with chilled liquid SO_2, and is separated into a refined oil phase and an extract phase. The extract phase contains most of the SO_2 used for the extraction, plus the bulk of the aromatics and sulfur bearing compounds normally present in the charge stock.

The raffinate phase, which contains a very small amount of SO_2, leaves the extraction tower at the top while the extract phase accumulates in the base section.

Both phases are pumped into their respective solvent recovery sections in which the SO_2 is removed in a series of evaporators.

Operating conditions include extraction temperatures of −10 to +20°F, with the final temperature depending upon the pour point of the charge stock.

At lower temperatures, SO_2 is more selective, and for this reason it is usually advantageous to use the lowest temperature possible consistent with charge stock pour point. The high selectivity of SO_2 permits the use of a very low SO_2 treat, 50-100%, coupled with a low number of extraction stages, usually 2-4.

The high specific gravity of SO_2 makes for rapid and complete separation of the phases in the extraction tower. Since SO_2 boils at 14°F, it is easily recovered from the kerosene.

Low specific and latent heats for SO_2 are important factors in the heat economy of the plant. The large part of the heat requirements in the solvent recovery system can be supplied with low pressure steam which makes it possible to use steam-driven compressors and to use the exhaust steam in the solvent recovery system.

Lamp oils are improved to a smoke point of 30 to 40 with the removal of 75-90% of the original sulfur and 85-95% of the original aromatics present in the feed. Raffinate yields vary from 75-90% by volume. The table shows the results of commercial treatment of different stocks.

Results of commercial SO_2 treatment of different kerosene stocks

	California Stocks *100 vol.% SO_2 @ +8°F*			Venezuela Stocks *65 vol.% SO_2 @ +14°F*		
	Charge	Raffinate	Extract	Charge	Raffinate	Extract
°API	38.4	42.5	26.8	41.3	45.0	27
Yield, vol.%	100.0	76.5	23.5	100.0	81	19
Aromatics, vol.%	18	2	75	——	——	——
Sulfur, wt.%	0.19	0.05	——	0.254	0.046	——
Smoke pt., mm	18	27	——	20	29	——
Solor, Saybolt	14	30+	——	13	30	——

Mild catalytic hydrogenation is one of the most promising new processes for finishing low quality fractions of kerosene boiling range into high quality kerosene.[8,9,10,11,12] This method of treatment is described in another paper in this symposium (see page 000).

Additives have not been used to any appreciable extent in kerosene used for heating and lighting, to date. Hydroquinone and substituted hydroquinones have been used to a limited extent to destroy color-forming bodies that result from oxidation during storage. This method of treatment is sometimes used to reclaim off-color kerosene in terminals.[6]

Distillate Heating Oils

The main objectives of distillate fuel oil treatment are the elimination of objectionable odors and improvement of storage stability.

To economically meet the high demand for distillate fuels, the refiner must produce them at a reasonable uniform rate throughout the year. Since consumption of fuels is much lower in summer, large volumes must be stored.

During storage, instable fuels will form insoluble sludges and gums which will cause malfunction of the burning, equipment through plugging of filter elements, pump strainers and nozzles.

Fig. 3 shows the two filter elements from domestic oil burners. Approximately the same volume of heating oil has passed through each filter. The fuel oil passed through the element on the left was of inferior quality from the standpoint of insoluble residue content. The element on the right represents the results obtained with a fuel oil containing very little insoluble residue.

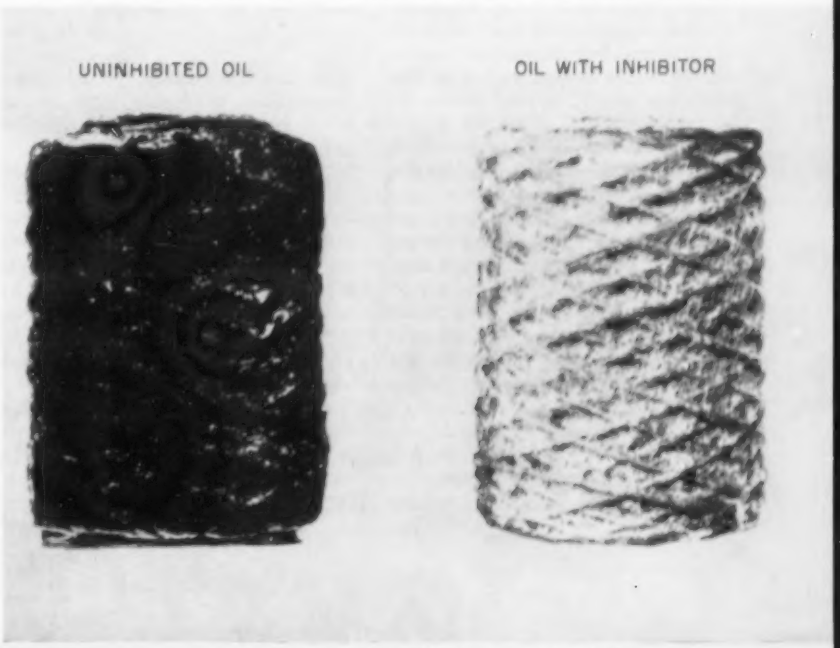
Another manifestation of storage instability is darkening of the color of the oil. While this darkening may not adversely affect the burning quality of the oil, the buying public has been educated to demand light colored distillate fuels.

The treatment given middle distillates to finish them into heating oils depends largely on the quality of the stocks.

Good Quality Raw Stocks

Straight-run distillates of the proper blending range from low sulfur crudes

Fig. 3—**TYPICAL DOMESTIC OIL BURNER FILTERS** after 1600 gal. consumption, comparing conditions with inhibited oil (right) and uninhibited oil (left)



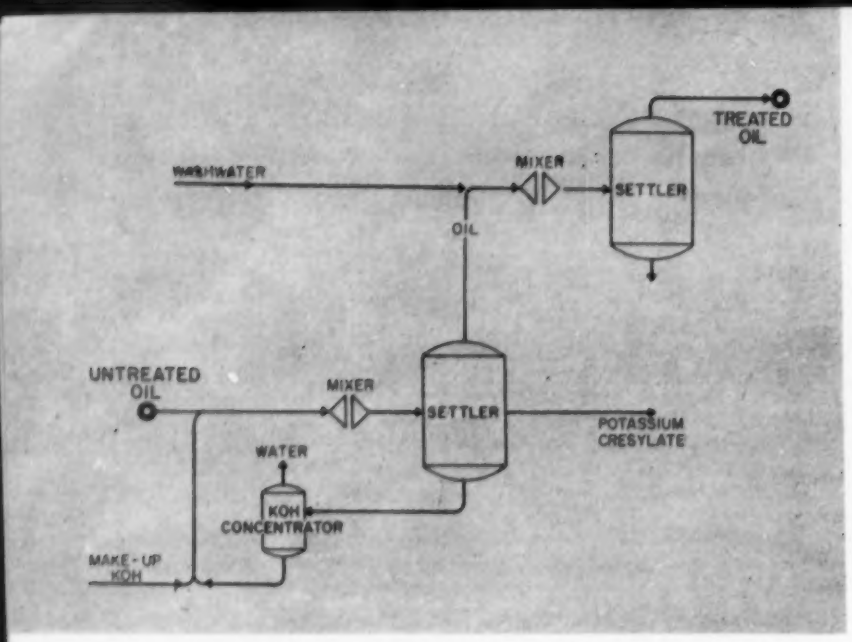


Fig. 4—**DUALAYER DISTILLATE FUEL-OIL TREATER** to stabilize cracked distillates

usually require no treatment other than removal of moisture which is dispersed in the oil by the steam used in the distillation process. In many cases, the fuel will brighten in storage. Sometimes, however, rock salt filters or blotter presses are used to remove the moisture.

A caustic wash to remove acidic compounds, such as mercaptans and phenols which may act as oxidation accelerators, is usually given to light catalytically cracked soluble oils yielded from low sulfur feed stocks.

After water washing and brightening, an anti-screen clogging agent is usually added to retard the formation of insoluble sludge and gum.

Medium Quality Raw Stocks

Straight-run fractions of the proper blending range having acceptable sulfur contents, but possessing disagreeable odors due to high mercaptan contents, are usually treated to convert the mercaptans to disulfides by the plumbite or other sweetening methods.

Care must be exercised in blending these straight-run stocks with cracked stocks, since inter-action between converted sulfur compounds and the unstable components of the cracked stock may result in instability with respect to insoluble residue. Additives which retard the formation of insoluble sludge and gum and reduce the size of the particles are commonly used to correct this condition.

One type consists of soluble dispersing agents which control particle size and keep them in suspension. They also prevent water from binding the sediment to form impassable mats on oil burner screens.

The second type combines dispersant properties with the ability to decrease the rate of formation of insoluble residue. Alkali and alkali earth sulfonates and certain non-ash containing materials are typical of those used for this purpose.[6,7]

The Dualayer process is a modified caustic wash treatment which has been used to finish catalytically cracked distillates having sulfur contents in the order of 1%. This process is used to stabilize cracked distillates with respect to color and sediment formation by selective removal of acidic compounds which act as oxidation accelerators, such as certain mercaptans and phenols.[12]

Usually potassium hydroxide, but sometimes sodium hydroxide is the treating agent. The strength is maintained in a range which allows the continuous removal of the deleterious compounds, in highly concentrated form, without impairing the effectiveness or composition of the reagent.

The Dualayer process uses the principle that systems containing caustic, water and organic acids separate into two layers when the caustic concentration is high. The upper layer of the two-phase system contains the sodium or potassium salts of the organic acids present in the distillate being treated. The lower layer is rich in uncombined caustic.

A flow diagram for a Dualayer distillate fuel oil treating unit is shown in Fig. 4. The cracked distillate is contacted with a 5 vol.% potassium hydroxide solution.

Treated product then is washed with water to remove entrained caustic solution, and is sent to storage. Some cracked distillates can be treated satisfactorily with sodium hydroxide, which is less expensive than potassium hydroxide. Whenever large quantities of acidic compounds are present in the oil, it may be advantageous to contact the oil first with sodium hydroxide solution to reduce the consumption of the more expensive potassium hydroxide.

The spent sodium hydroxide and potassium hydroxide solutions are handled similarly in separate recovery systems. The spent caustic solution separates into two layers because of the absorption of organic acid from the oil. This is done in the treating vessels, but separate vessels located before or after the concentrators may be used.

The upper layer, which contains the organic acids, is discarded, inasmuch as its free caustic content is very low. These acids may be recovered by acidification of the solution or by other conventional methods.

The lower layer, which contains caustic and water, is passed through a concentrator in which water is removed to control the composition of the treating solution.

In treating oils by the Dualayer process, a 40 wt.% sodium hydroxide solution is employed, as compared to a 50 wt.% potassium hydroxide solution. This is necessary because of the high viscosities of sodium hydroxide solutions, which make their use in high concentrations commercially impractical.

Consumption of chemicals by the Dualayer process is low because only a small amount of unreacted caustic is removed from the unit with the organic acid salt layer.

Costs of treating chemicals depend on the amount of acidic compounds removed from the oil and on the type of caustic solution used.

Treating losses are reported to be only a fraction of 1% since only the acidic compounds are removed.

Low Quality Raw Stocks

Middle distillates from certain crudes are very difficult to finish into fuels which are competitive in the present market. They may have high sulfur or nitrogen contents, contain high concentratoins of aromatics, or have offensive odors. All these properties adversely affect quality, and unusually severe refining is required to eliminate them.

A distillate from West Texas high-sulfur crude oils is a good example of such a product. Its high mercaptan content makes it difficult to sweeten by conventional methods, such as doctor sweetening. Even the sweet product has a bad odor due to cyclic sulfides, and the sulfur content is high. The burning quality is also poor due to the high aromatic content.

Processes which have been used successfully to finish such distillates include sulfuric acid treating, solvent extraction, and mild hydrogenation.

Sulfuric acid treatment has been used successfully to make these low quality stocks marketable.

Mild acid treatment markedly reduces the mercaptan content, but it has little effect on the odor, total sulfur content or burning quality. Acid treatment severe enough to improve all the properties results in excessive loss of product and usually requires expensive rerunning.

Solvent extraction, using furfural as a selective solvent, for the extraction of middle distillates effects a reduction in sulfur content, improvement in burning quality and upgrades catalytic cycle stocks to straight-run quality.[14] Furfural extracted catalytically cracked distillates need no further treatment for use as heating oils.

A furfural treating unit embodies a counter-current extraction tower, product strippers and solvent recovery equipment. By the use of decanters and a water wash tower, distillates having an initial true boiling point of 325°F or higher can be satisfactorily processed.

In one commercial unit using approximately 25% solvent dosage, 50% sulfur removal and 75-80% raffinate yield is obtained.

The economic success of this treating method depends largely on profitable disposal of the extract.

Mild hydrogenation is being used widely to finish low quality straight-run, catalytically cracked and thermally cracked distillates into high quality fuels.[8,9,10,11,12] The saturation of unsaturates and the removal of sulfur, nitrogen and oxygen with no loss in yield make this method of treatment very attractive.

One of the newer approaches to producing high quality catalytically cracked fuels from low quality crudes is mild hydrogenation of the cat feed stock. Drastic reduction in sulfur content is achieved, and the cat cycle oils yielded from pretreated feed stock may be finished into good quality fuels by the simple methods normally used for cycle oils from low sulfur cat feed stocks.

Jet Engine Fuels

Jet engine fuels are usually blends of gasoline and kerosene or straight kerosene. The total sulfur and mercaptan sulfur contents allowable are higher than those normally tolerated in kerosene used for heating and lighting.

Military Specifications on jet engine fuels specify that a corrosion inhibitor shall be added to the fuel. An oxidation inhibitor may be added to prevent the formation of gum.

A trend toward the use of the fuel as a cooling medium for the jet engine lubricating is going to increase the stability requirements of the fuel greatly. The fuel must withstand elevated temperatures without forming sludges and deposits which will plug filter elements in the fuel system.

Indications are that removal of the sulfur, oxygen and nitrogen compounds by acid treatment or mild hydrogenation will give a satisfactory fuel for use in engines which use the fuel as a coolant. Some authorities advocate the use of additives in the form of dispersants to prevent sludge and gum coagulation.

Diesel Fuel Oils

Diesel fuels have, in addition to all of the quality requirements of heating oils, minimum cetane or ignition quality requirements. Highly aromatic fuels have poor ignition characteristics.

Good quality straight-run heating oils can be used as diesel fuels without additional treatment.

Low cetane catalytically cracked distillates may be converted into diesel fuel by reduction of the aromatic content by solvent extraction or hydrogenation. The ignition quality of the stocks can also be improved by adding small amounts of organic nitrogen oxides or peroxides. Primary amyl nitrate is gaining acceptance for upgrading conventional fuel oils into diesel fuel.

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Mercaptans in Gasoline and Its Components

Removing and Converting

By H. E. WALKER and E. B. KENNEY, Shell Oil Co.

THE production of the normal grades of finished gasoline meeting marketing specifications and customer acceptance from the primary components available in a refinery involves treatment of many of the stocks, selective blending and finally the use of additives such as TEL, antioxidants and more recently, preignition control additives such as TCP.

Treating operations effect the partial or total removal or conversion of small quantities of deleterious constituents present in the unfinished product. The deleterious compounds may be hydrocarbons (e.g. some diolefins) or non-hydrocarbons (e.g. sulfur or oxygen compounds). This group of constituents will be referred to as contaminants.

Most of the contaminants fall in the non-hydrocarbon group and essentially all of the contaminants occurring in unfinished gasolines are formed by chemical changes taking place during primary processing from other more complex substances originally present in the crude.

These facts have led to research for means to remove or convert most of the sulfur, oxygen and nitrogen compounds by treatment of the crude itself, and thus secure certain major process advantages and eliminate the bulk of this gasoline treatment. To date the comparative economics and technical problems have been such that no refinery has been based on crude pretreatment of this type.

As is evident from Table 1, the contaminants present in unfinished gasolines have a significant effect on fuel performance and customer acceptance. Furthermore, these effects have become steadily more important since the continuing trend toward higher engine horsepower, compression ratio, speed, etc., inevitably results in increasingly severe demands on the fuel.

Some of these adverse effects can be eliminated by proper use of additives and this course has been adopted whenever it was technically feasible and economically justifiable. For example, inhibition generally proves sufficient to stabilize cracked gasolines against gum formation from reactive hydrocarbons provided certain promoters (e.g. aryl mercaptans, copper) are absent or deactivated.

One of the conventional treating alternatives would be acid treating and redistillation which essentially eliminates the gum formers but results in losses of significant amounts of high octane number non-gum-forming olefins and aromatics. In many cases, however, removal or conversion of the contaminant to a less objectionable form is the only available solution.

Referring again to Table 1, it will be noted that the contaminants may be grouped into acidic (H_2S, mercaptans, naphthenic acids, phenols), basic (nitrogen bases), and neutral (sulfur excluding H_2S and mercaptans, reactive hydrocarbons) categories.

To date the nitrogen base problem has not been deemed very significant in most refineries, and it will therefore be omitted from this discussion. There are, however, indications that the importance of nitrogen bases to engine cleanliness is being revaluated.

Since trace metals are readily inactivated by chelation with metal deactivators, no treating procedures for their removal are required.[21]

The fact that gum formation from reactive hydrocarbons can generally be suppressed by simple inhibition is discussed in one of the other articles in this symposium (pp. 000).

With the notable exception of the West Coast, the removal of neutral sulfur compounds is not required in the majority of refineries in order to meet present total sulfur specifications. Where either reactive hydrocarbon or neutral sulfur removal is necessary, clay processing and especially hydrotreatment both of which lie beyond the scope of this article, are generally supplanting the older acid treatment and redistillation. Some new chemical treating procedures which might partially reverse this trend are still in the development stage.[12]

This leaves for discussion the removal of acidic materials, which is the field in which chemical treatment is not only predominant, but relatively unchallenged. Even this apparently restricted field is far too large to be handled in a brief article, and it has therefore been necessary to limit the discussion to the major commercial processes.

Because of processing economics, H_2S when in low concentration, naphthenic acids, aryl mercaptans, and alkyl phenols are almost always removed by a non-regenerative caustic treatment. In contrast, treatment for alkyl mercaptan removal or conversion is usually but not always regenerative.

Non-Regenerative Caustic Treating

Hydrogen Sulfide Removal

Since H_2S can be segregated by fractionation in the propane and lighter (non-gasoline) fractions to a major extent, the concentrations encountered in gasoline components are generally so low that use of the reagent on a once-through, non-regenerative basis is usually the most economic solution.

If, for some reason, the concentration is high, the Girbotol [1] and Shell tripotassium phosphate [2] regenerative processes are available.

The alkaline reagents normally employed for non-regenerative H_2S removal are calcium, ammonium and sodium hydroxides, with the last being by far the most widely used. The limited solubility of the calcium hydroxide (and resultant sulfides) presents difficult handling and contacting problems while the cost of ammonia normally limits its use to injection into distillation and cracking units to neutralize

Mercaptans

H_2S and other acids in situ and prevent equipment corrosion.

The reaction of H_2S and NaOH proceeds as follows:

$$2NaOH + H_2S = Na_2S + 2H_2O \quad (1)$$

$$Na_2S + H_2S = 2NaHS \quad (2)$$

If the solution and gasoline are adequately contacted, H_2S will be reduced to a concentration of less than 0.0001 wt.% in the product until about 85% of the Na_2S formed is converted to NaHS. Accordingly, units for this operation are designed to secure the maximum permissible caustic conversion by employing process schemes such as shown in Fig. 1. (The second stage is employed where caustic economics warrant).

Usually 10-20° Bé NaOH and a 2:10 ratio of circulating caustic to gasoline are utilized. Although fresh caustic is often used, important savings can be effected when partially spent caustic from some other process is available. For instance, it is normal practice to employ high salt content Doctor solution which has been discarded after lead recovery, or caustic which has been drawn off a regenerative mercaptan removal system owing to phenol or sulfide accumulation.

Operating temperature and pressure are not of major importance provided reagent dehydration and gasoline vaporization are avoided. Since no significant corrosion is encountered, carbon steel construction is adequate.

Aryl Mercaptan Removal

Since the simplest aryl mercaptan, thiophenol, boils at 337°F. these compounds are concentrated in the higher boiling gasoline fractions and comprise a very limited number of individual components. They are markedly stronger acids than the alkyl mercaptans, and are readily removed to a 0.0004 wt.% mercaptan sulfur level by a non-regenerative caustic wash.

Although numerous variations are possible, the unit shown in Fig. 1 is fairly representative. The staging shown is not required for thiophenol removal, but permits operation at significantly reduced caustic consumption.

An interstage coalescer is often added to reduce caustic carryover from the high mercaptide to the low mercaptide content caustic stage. Carryover is a problem since the solution can be used to high conversion levels where the viscosity is significantly greater than that for pure caustic.

Caustic concentrations ranging from 15-40° Bé are reported; recirculation ratios of 0.1-0.2:1 are employed. Caustic efficiencies of 50% and higher are possible.

Pressures and temperatures are those prevailing in the gasoline rundown system, usually around 100°F and 35 psig.

Naphthenic Acid Removal

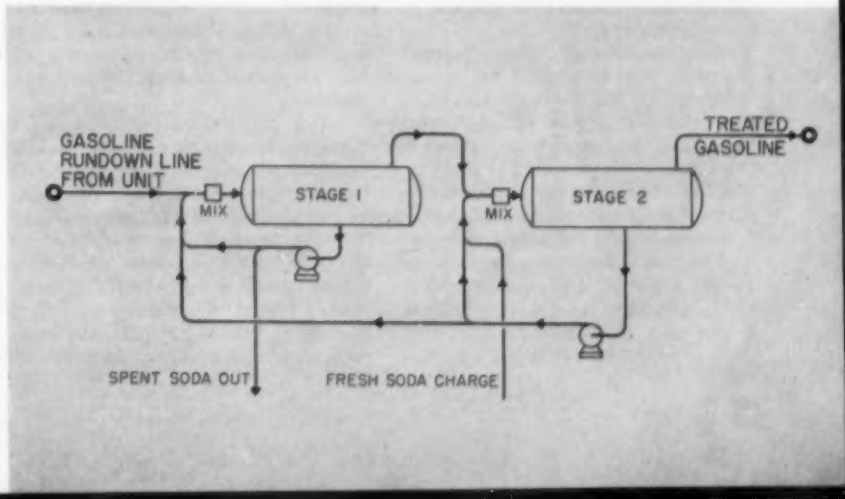
Naphthenic acid removal often comprises one reason for pretreatment of feed to treating units. It may be readily effected by simple one-stage caustic washing in a mixer-settler unit. When this removal is being carried out only to lower acidity, the caustic is employed until exhausted (perhaps 25% naphthenates).

Recovery of the acids for by-product sales is common practice, but the details lie beyond the scope of this paper.

Table 1—Deleterious effects of major contaminants found in untreated gasoline components

Contaminant	Effect
Hydrogen sulfide	Acidity, corrosivity, noxious combustion products, reduced octane number and TEL susceptibility, odoriferous.
Alkyl mercaptans	Corrosivity, noxious combustion products, reduced octane number and TEL susceptibility, odoriferous.
Aryl mercaptans	Corrosivity, noxious combustion products, reduced octane number and TEL susceptibility, gum formation, engine deposits, odoriferous.
Naphthenic acids	Acidity, corrosivity.
Phenolic compounds	Possible effect on engine intake deposits.
Total sulfur	Corrosivity, noxious combustion products, reduced octane number and TEL susceptibility.
Highly reactive hydrocarbons (some cyclic and conjugated diolefins, toluenes)	Gum formation, engine deposits, fuel discoloration.
Nitrogen bases	Odoriferous, color formation, possible engine deposits.
Traces of metals (primarily copper)	Gum formation, engine deposits.

Fig. 1—**CONTINUOUS COUNTER-CURRENT TWO-STAGE CAUSTIC SCRUBBER,** once-through non-regenerative type, for treating light petroleum fractions



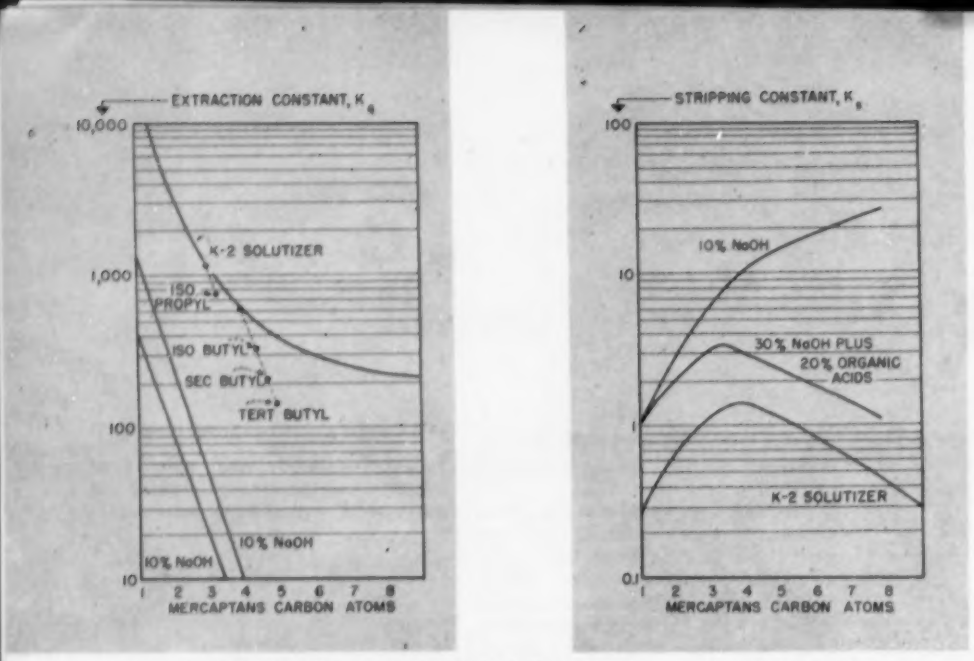


Fig. 2—**EXTRACTION AND STRIPPING COEFFICIENTS** as affected by various types of treating solutizers

Alkyl Phenol Removal

Partial alkyl phenol removal by simple caustic scrubbing is required as a pretreatment for numerous treating procedures, and as such will be discussed in several later sections.

As with the naphthenic acids, recovery for by-products sales is practiced.

Treatment for Removal or Conversion of Alkyl Mercaptans

The alkyl mercaptans are found throughout the gasoline boiling range, but are usually concentrated to a considerable extent in the butane and light gasoline fractions.

Accordingly, it is often possible to concentrate the alkyl mercaptans by fractionation and then either confine mercaptan treatment to this fraction or treat this fraction for mercaptan removal while treating the small amount in the remaining fraction by a simple conversion process.

Since crudes and refinery primary processes vary so greatly, no general rules can be offered with regard to the optimum degree of mercaptan segregation by fractionation prior to treatment.

Alkyl mercaptans are deleterious because of their odor, their contribution to noxious engine exhausts and engine corrosion and their adverse effect on octane numbers and lead susceptibility. They have been treated because of the odor problem since the early years of the automobile industry, but their contributions to the other problems indicated were not fully appreciated until about 1940.

Until that time, a process which converted mercaptans to a less odoriferous material (disulfides) was generally accepted as a satisfactory method of treatment.

The Doctor test, which was developed in conjunction with the Doctor sweetening process discussed, was the accepted test for satisfactory mercaptan conversion for many years.

A Doctor sweet gasoline contains less than 0.0003-0.0006 wt.% mercaptan sulfur. This indicates the test was over-severe, since odor improvement was the objective of Doctor treatment, and studies have shown that no mercaptan odor can be detected in gasolines until the concentration approaches 0.002-0.003 wt.%.

A decade of studies by various investigators culminating in and reviewed by Ryan's paper[20] which appeared in 1942 established that hydrogen sulfide, mercaptans, and alkyl disulfides had equivalent adverse effects on octane number and lead susceptibility.

These effects were markedly larger than those resulting from similar amounts of thioethers or thiophenes but were less than those produced by polysulfides. These facts, combined with the desirability of reducing overall sulfur level in order to reduce engine corrosion and noxious exhause fumes, placed a premium on alkyl mercaptan removal rather than conversion, whenever the concentration is high enough to make the resultant improvements significant.

Normally, streams containing less than 0.1wt% alkyl mercaptan sulfur are treated by conversion processes, while streams containing more than 0.05 wt.% are generally treated for mercaptan removal.

No general rules as to when to use one or the other approach can be offered for the 0.01-0.05 wt.% range since the answer depends not only on the mercaptan content, mercaptan distribution and quantity of the stream under consideration, but also on the over-all gasoline blending position and product specifications.

Furthermore, the decision as to optimum alkyl mercaptan treating process for a specific case cannot be based solely on the effect on alkyl mercaptans; the effects on all gasoline properties must be considered.

For instance, as will be pointed out subsequently, it is very difficult to suppress polysulfide formation completely during Doctor treatment. The slight increase in total sulfur content is usually inconsequential, but the depressant effect of polysulfides on octane number, lead suspectibility and gasoline gum and color stability is often signficant.

On the other hand, Doctor treatment produces a peroxide free gasoline, whereas the peroxides encountered in the polysulfide free gasoline prepared by air-inhibitor treatment may result in engine cleanliness problems.

Similar examples of strengths and

weaknesses are cited for all the processes discussed below and are summarized in Table 2 which compares the salient points of the various removal and conversion processes.

Alkyl Mercaptan Removal

All processes emphasized commercially for the removal of mercaptans are based on the use of an alkaline reagent which reacts with the mercaptans to form mercaptides in accordance with Equation 3:

$$RSH+NaOH = RSNa+H_2O \quad (3a)$$

$$RSH+KOH = RSK+H_2O \quad (3b)$$

As has already been pointed out, removal processes are normally employed on medium to high mercaptan content materials, and at these concentrations a regenerative process is generally most economic. The alkaline reagent used for mercaptan removal can be recovered and the contaminant isolated either by steam stripping (Equation 3 reversed or air oxidation (Equation 4):

$$4RSNa+2H_2O+O_2 =$$

$$2RSSR+4NaOH \quad (4)$$

As may be seen from Fig. 2, the Extraction Coefficient, K_e (concentration of RHS in reagent/concentration of RHS in hydrocarbons) and the Stripping Coefficient, K_s (concentration of RHS in the vapor/concentration RHS in reagent) vary with mercaptan molecular weight and structure and reagent type and composition.

In consequence it is economically feasible to reduce the mercaptan sulfur concentration of butane and isopentane to about 0.0004wt.% with steam regenerative NaOH treatment.

Since the stripping coefficient (K_s) increases much less than the extraction coefficient (K_e) decreases, prohibitively high circulation and steam rates are required to regeneratively sweeten higher molecular weight materials in this manner.

Normally no attempt is made to regeneratively caustic treat hydrocarbons boiling above 200°F, since even with a feed having a boiling range from pentane to 200°F the overall mercaptan removal is only 50-75%.

The solutizer process[22] developed in 1939 changed this picture. This process utilized suitable organic solvents or salts in the aqueous phase to markedly improve the solubility of mercaptans in this phase.

As shown in Fig. 2, the use of solutizers such as potassium alkyl phenolate (KAP) and potassium isobutyrate (KIB) increases the extraction coefficient (K_e) more than it reduces the stripping coefficient (K_s), and thereby makes possible regenerative processes which are effective and economic in the higher moleucular weight ranges.

Air regeneration which was the next step in solutizer development eliminated the stripping problem entirely.

Although theoretically most of these regenerative processes can be used to reduce the mercaptan sulfur content to the Doctor sweet level, it is often economically preferable to employ them to lower the concentration only to the odor sweet level (about 0.002-0.003 wt.%). Then if further sweetening is required, a conversion process is employed as a final stage.

Pressure, as such, has no effect on mercaptan extraction, provided it is sufficient to prevent hydrocarbon vaporization.

Temperature, solution composition, and viscosity are important interrelated variables. The extraction coefficient is adversely affected but the viscosity is lowered and settling characteristics are improved by increasing temperature.

Extraction units are operated at the reagent composition and temperature giving the best over-all process economics. The resultant temperature usually approximates that of cooling water and lies in the 80-110° range.

Typical flow schemes indicating the major essential features of regenerative caustic and steam and air regenerative solutizer processes are shown in Figs. 3-5. The discussion also indicate briefly the other points of similarity and dissimilarity with commercially available extraction processes.

The regenerative caustic treater shown in Fig. 3 is a unit for sweetening of isopentane. The design is entirely straighforward and conventional, embodying simply a packed column countercurrent extractor employing a caustic/hydrocarbon ratio of 1:10 and a temperature of 85°F, a bubble tray open steam regenerator using 5 lb. steam/gal. caustic and the necessary auxiliaries.

The two to three theoretical stripping and extraction stages provided represent about the optimum balance between capital and operating costs.

Variants on this basic design which are encountered include the use of 2 or 3 mixer settler stages or other contacting system instead of a packed

Table 2—Comparison of regenerative sweetening processes

Process	Normal Feed	Normal Mercaptan Range, wt.%	Effect on Octane No. and TEL Susceptibility	Effect on odor	Remarks
Caustic	C_4, C_5 light gasoline	0.01 and up	Improves	C_4, C_5 Doctor sweet, gasolines usually not	Has no competition in C_4, C_5 treating. Not too satisfactory on heavier stocks
Solutizer	Most cracked and straight-run gasolines	0.02-0.05 and up	Improves	May be Doctor sweet but usually odor sweet	Mercaptan *removal* gives this process big advantage on high mercaptan content stocks.
Doctor	All gasolines	No limits	Some lowering	Doctor sweet	Very versatile.
Copper Chloride Slurry	Most cracked and straight-run gasolines	Up to about 0.04	Little change	Doctor sweet	In certain cases soluble copper must be deactivated with an additive.
Copper-Fixed Bed	Straight-run gasolines	Up to about 0.04	Little change	Doctor sweet	See above.
Air-Inhibitor	Cracked gasolines	Up to 0.02-0.03	Little change	Usually odor sweet	In certain cases may form peroxides with resulting poor stability.
Air Solutizer	All gasolines	No limits	Little change	Doctor sweet	Versatile.

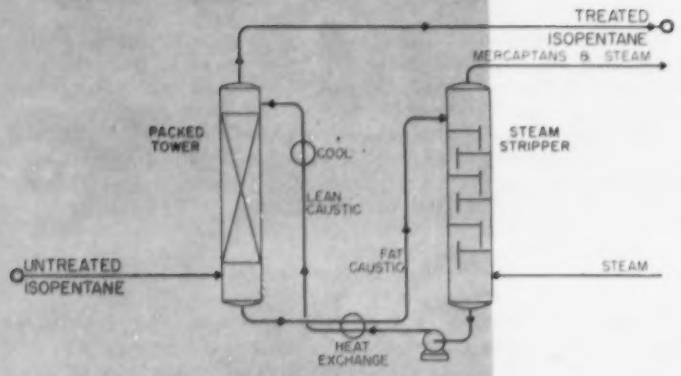


Fig. 3—**REGENERATIVE CAUSTIC** treater for mercaptan removal from isopentane

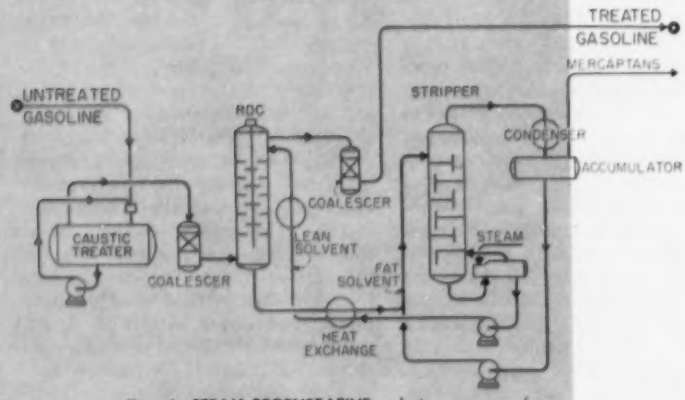


Fig. 4—**STEAM-REGENERATIVE** solutizer process for materials in the gasoline range

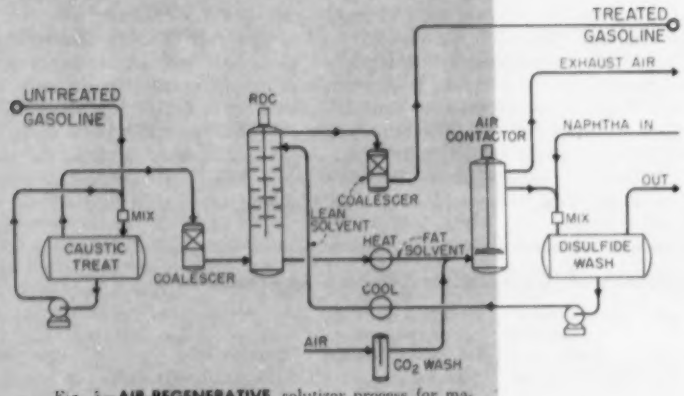


Fig. 5—**AIR-REGENERATIVE** solutizer process for materials in the heavy gasoline range

column, caustic prescrubbing (if H_2S is present) and closed stripping (reboiler plus diluent injection).

The mercaptans which are isolated are disposed of via either burning or by-products sales.

Materials of construction are conventional; thorough stress relieving normally suffices to protect the high temperature points from corrosion although in some cases Monel has been required.

The 20° Bé caustic which is normally employed can be used in a fully closed cycle for periods of months without replacement provided the feed is essentially sulfide free. Eventually, however, it becomes contaminated by impurities present in trace amounts in the feed, mechanical entrainment, etc. and must be replaced.

Since most refineries have major non-regenerative uses for caustic, it is common practice to charge fresh caustic to the regenerative units and withdraw regenerated caustic as needed to supply these other uses, in this way maintaining the regenerative unit inventory of caustic in an essentially fresh condition.

Air regeneration similar to that used in air regenerative solutizer processing is also employed with caustic-butane and caustic-isopentane systems. Electrolytic regeneration of spent caustic (using oxygen liberated from the aqueous caustic in electrolytic cells) is also employed.[23]

The steam regenerative solutizer process[22] shown in Fig. 4 is a direct adaptation of the caustic/isopentane treater to the problems encountered in the gasoline boiling range; the essentials of countercurrent extraction and steam stripping remain unchanged. The major change required is of course the use of a solutizer solution in place of caustic; the other changes follow from this as necessary auxiliaries.

Although either sodium or potassium based solutions can be employed, the latter are usually favored despite their higher costs since they yield higher extraction coefficients at acceptable solution viscosities. A typical fresh solutizer solution composition is 5.0 N KOH, 2.0 N KAP.

The potassium alkyl phenolate is generally prepared by KOH extraction of a suitable refinery stream and is then maintained by alkyl phenols present in the feed stock. The properties of the gasoline-solutizer system are such that settling and extraction are both more difficult than in the NaOH/isopentane system. Accordingly, although earlier units employing packed columns and mixer settlers are still in successful operation, the rotating disc contactor[17] appears likely to replace them for many units. In view of the settling problem and high chemcal value, after-coalescers are employed to eliminate carryover.

Furthermore, a caustic prewash is provided to protect the solution from mechanical entrainment and sulfide and organic acid contamination, and to adjust the feed alkyl phenol content to prevent KAP buildup or depletion in the solutizer.

The feed coalescer prevents caustic carryover into the solutizer. The regeneration system is conventional. Roughly 2-3 extraction and stripping stages are provided.

A 2:10 ratio of solutizer/gasoline is employed with a treating temperature of 100°F. A steam consumption of 2 lb./gal. solutizer circulated is typical. The mercaptans isolated are

disposed of by burning or by-products sales.

Variants on this basic pattern include other methods of countercurrent extraction, the use of open steam for stripping and omission of the prewash combined with use of a more expendable sodium base solutizer. Carbon steel construction is used throughout except for the cupro-nickel alloy tube bundle in the stripper reboiler.

The Dualayer process[8] flow scheme is almost the same as that shown in Fig. 4, but the treating medium proposed is considerably more concentrated, consisting of a KAP-rich solution which has been equilibrated with a 50% KOH solution.

Such a solution would allow operation with a lower solution-to-gasoline ratio or alternatively a high mercaptan removal efficiency. A possible source of difficulty resides in the high viscosity of the solution, which can lead to emulsification. The first commercial unit of this type is under construction

The Unisol process[9] utilizes a caustic-methanol extraction solution with resultant additions to the recovery system—e.g. treated gasoline water wash for methanol recovery and a methanol fractionator. The mercaptan removal resulting is comparable to that obtained in solutizer treatment.

The Mercapsol process[11] utilizes a caustic-naphthenic-cresylic or coal tar acid reagent and steam regeneration.

The air-regenerative solutizer process[15] shown in Fig. 5 represents the next improvement on the original caustic-steam system; its major advantage lies in its ability to satisfactorily treat heavy gasolines without excessive utility costs.

It differs from the steam process only in the regeneration procedure, which consists of contacting (in a turbo-aerator or equivalent) CO_2 free air and essentially gasoline-free spent solutizer solution at temperaures of 125-175°F, pressures from 40-100 psia and residence times of 10-20 minutes. Air utilization efficiencies range from 15-50% of theoretical.

The resultant disulfides are extracted by wash naphtha (e.g. charge to thermal reforming) and the regenerated solutizer is then recycled to the extraction step. A filter is provided to prevent the accumulation of trace quantities of oxidation by-products in the solution.

An important earlier modification of this scheme involved the use of tannin as an oxidation catalyst. This facilitated regeneration at lower temperatures and pressures and with less thorough mixing, but the tannin also promoted undersirable side reactions leading to solution contamination and consequently increased chemical costs.

Newer units are being built for uncatalyzed air regeneration, and a number of the older units have been converted. Carbon steel construction is used throughout.

Variants on this scheme involve the use of other contacting devices and a regenerative disulfide wash system using butane which is then flashed overhead and recycled, leaving a disulfide oil fraction as bottoms. Air regeneration is also used in conjunction with the Mercapsol process.[6]

Alkyl Mercaptan Conversion

Although there are a large number of conversion processes employed commercially, Doctor, copper chloride air/inhibitor and air/solutizer sweetening account for the bulk of the installed capacity. These processes are similar in that the major overall reaction in each case is the formation of disulfides from mercaptans.

All the processes are affected by mercaptan type and molecular weight, with the former being the major factor. The difficulty of treatment increases from the normal through the tertiary configuration, with the latter sometimes proving impossible to convert by certain of the processes at reasonable conditions. This behavior is parallel with the increasing difficulty of extraction in removal processes. As a result the choice of a conversion process to "clean up" residual mercaptan left by a removal process is often critical, since the residual is probably high in tertiary mercaptans.

Doctor treating, which was the first of these to be employed commercially, is probably the most complex. It has been found suitable for treating successfully any molecular weight gasoline of any mercaptan content (with reservations on tertiary mercaptans), and can be operated on either a batch or continuous, regenerative or nonregenerative basis. Its flexibility and reliability have kept this process in a competitive position for many years.

As shown in Fig. 6 the continuous process consists of four steps. The caustic prewash employing discarded spent Doctor solution removes traces of H_2S and acidity, adjusts the phenolate concentration to minimize buildup in the solution and permits the recovery of lead (as colloidal PbS or soluble lead mercaptide) from the discarded solution.[14]

In the second stage of the process about 20 parts of Doctor solution (typically 150 g/l NaOH in which 10-15 g/l PbO has been dissolved to form sodium plumbite—Na_2PbO_2—the active ingredient) reacts with the mercaptans in 100 parts of gasoline to form mercaptides. The major reaction is:

$$2RSH + Na_2PbO_2 = (RS)_2Pb + 2NaOH \quad \ldots (5)$$

although basic lead mercaptides have also been noted.

Approximately 30 seconds contact time are required to permit complete mercaptan reaction, which is desirable if polysulfide formation with its pronounced adverse effects is to be minimized in the ensuing step.

A slip stream of gasoline containing dissolved sulfur is then mixed with the gasoline stream containing lead mercaptans. Polysulfide formation occurs if the sulfur supposed to react with the mercaptides as follows:

$$(RS)_2Pb + S = RSSR + PbS \quad (6)$$

instead contacts unconverted mercaptans and reacts as follows:

$$2RSH + 2S = RSSSR + H_2S \quad (7)$$

Fortunately the latter reaction appears to proceed rather slowly. Reactions involving $Pb_2S(SR)_2$, $Pb_2(OH)_2S_2$, $Pb_2(OH)_2S_4$, etc. are also reported, indicating the actually complex nature of the reaction. The RSSR or RSSSR formed of course appears in the treated gasoline.

It is essential that sulfur addition (for desired Equation 6) be carefully controlled, since in the presence of any excess, polysulfide formation occurs.

$$(RS)_2Pb + XS =$$

$$RS_{x+1}R + PbS \quad (8)$$

In order for Reaction 6 to proceed to completion without the addition of excess sulfur, 5-15 minutes reaction time with stirring of the reactants is required.

Finally, the spent Doctor solution is regenerated by air blowing at temperatures of 180-230°F and pressures of 15-100 psia. Air utilization is higher at the more severe conditions. The resultant reactions are extremely complex, but are approximated by:

$$PbS + 2O_2 + 4NaOH = Na_2PbO_2 + Na_2SO_4 + 2H_2O \quad (9)$$

The overall desired sweetening reaction (Equations 5, 6, 9) is then:

$$2RSH + S + 2O_2 + 2NaOH = RSSR + Na_2SO_4 + 2H_2O \quad (10)$$

Thus, under ideal conditions there would be no increase in gasoline sulfur content and no change in octane number or lead suspectibility. Unfortunately the ideal is practically unattainable, and varying degrees of polysulfide formation are encountered with different stocks. Polysulfide formation is especially prevalent when treating tertiary mercaptans.

The use of NaOH, S and O_2 to form the useless by-product Na_2SO_4, with the consequent need for continuous or intermittent makeup and withdrawal is an adverse feature of the process.

The process outlined above is extensively varied in commercial applications, e.g. by omission of prescrubber and time coil, inclusion of an afterwash stage, provision of coalescers, operation at elevated temperature, and use of widely different solution compositions. No corrosion problems are encountered and carbon steel construction is adequate.

Copper chloride sweetening is accomplished in fixed-bed, slurry and solution processes, which are identical in principle but differ in method. In the first two the reagent is supported on a solid inert carrier, whereas in the solution process an aqueous copper chloride solution is employed.

The fundamental reactions involved are, in simplified form:

$$4RSH+4CuCl_2 = 2RSSR+4HCl+4CuCl \quad (11)$$

$$4CuCl+4HCl+O_2 = 4CuCl_2+2H_2O \quad (12)$$

Overall:

$$4RSH+O_2 = 2RSSR+2H_2O \quad (13)$$

The advantages over Doctor treating with regard to polysulfide formation and reagent consumption are obvious. However, the sweetening reaction proceeds very slowly with tertiary mercaptans, and stocks containing high concentrations of these mercaptans are normally excluded.

The solution process will not be dealt with in any detail, since the corrosion problems encountered have greatly limited its application. In the fixed bed and slurry processes, the reactions in Equations 11 and 12 proceed simultaneously, as sufficient oxygen is present or has been added to the gasoline stream to immediately regenerate the cuprous chloride.

Since incomplete regeneration has an adverse effect upon the gum content and inhibitor susceptibility of the product, 1.5-3 times the theoretical amount of oxygen is always supplied. In some cases this introduces the problem of hydrocarbon peroxide formation, with its attendant adverse effects on stability.

Although Equation 13 indicated no reagent consumption, in practice some is consumed by reaction with feed stock impurities, and some copper is lost to the product either mechanically or by reaction.

Furthermore, it has been noted that certain reagent-reactive hydrocarbon reactions occur especially when the space velocity is significantly reduced below design in fixed bed units. In consequence, the fixed bed process is normally limited to straightrun stocks.

Since minute traces of copper catalyze gasoline deterioration this material must be removed or deactivated This point has been a significant factor in the decision for or against copper treatment in a number of cases.

The most serious feed contaminants are H_2S, NaOH and water. The first is minimized by caustic washing and the second by adequate settling or coalescing after the prewash. Since water is an end product of the sweetening reaction, and the catalyst loses activity when dehydrated and physical strength on over-hydration, control of feed water content is essential. Generally, elimination of entrained water and heating of the feed enough to insure dissolving of the water produced is sufficient.

The need to dissolve the water formed in the effluent gasoline, combined with other factors, normally limits the allowable mercaptan sulfur content of the feed to about 0.04 wt. %.

Alkyl phenols and naphthenic acids which deactivate the catalyst or contaminate the product are removed by a caustic prewash.

Nitrogen bases are also undesirable, but since they are difficult to remove, use of the process is normally limited to streams relatively free of these contaminants. However, some refiners have taken the alternate course and extensively pretreat the charge.

Reactor temperature is important in maintaining complete sweetening, proper reagent hydration and good colour and colour stability of the product. Normally, temperatures above 120°F result in undersirable secondary reactions, while temperatures below 80°F result in inadequate sweetening unless the charge mercaptan content is very low.

Although a water wash is partially effective in removing copper from the product, the simplest remedy is the use of a chelating agent to sequester the copper and inactivate it. Sodium and zinc sulfide after treatments are also employed.

The typical flow sheets detailing the essential features of the fixed bed and slurry processes (Figs. 7 and 8) indicate how the principles outlined above are carried out in practice.

It should be noted that either air or oxygen can be employed in the slurry process. The Perco variants[7] employ air because of its simplicity and low cost. The Linde[12] and Airco-Hoover[9] slurry variants employ oxygen in order to minimize the hydrocarbon losses in the gases vented after treatment (in one case excess O_2, in the order excess O_2+N_2).

The use of an eductor to draw the slurry ($CuCl_2$ impregnated on finely divided clay or diatomaceous earth) from the hopper into the gasoline stream is characteristic in the slurry process. Corrosion problems are not severe, and carbon steel is normally employed. Protection of the eductor against erosion-corrosion is necessary.

The UOP fixed-bed process[6] differs from the Perco process shown in reagent (a mixture of NH_4Cl and $CuSO_4$

Table 3—Mechanism of Sweetening[16]

Caustic Absent	Caustic Present
A—Free Radical Production	**A—Caustic Phase**
1—Gasoline Radicals:	$RS^- + O_2 \rightarrow RSSR$
$\xrightarrow{O_2}$	$RS^- + RCOO^- \rightarrow RSSR$
Gasoline $\rightarrow R^\bullet \rightarrow ROO^\bullet$	**B—Gasoline Phase**
$ROOH \rightarrow RO^\bullet$	$RCOO^- + RSH \rightarrow RSSR$
2—Inhibitor Radicals:	$RCOO^- + In^\bullet \rightarrow$ Quinone Imide
Gasoline Radical + H In $H \rightarrow In\ H^\bullet$	
3—Mercaptyl Radicals:	
Gasoline Radical + $RSH \rightarrow RS^\bullet$	
Inhibitor Radical + $RSH \rightarrow RS^\bullet$	
B—Mercaptan Disappearance	
$RS^\bullet + RS^\bullet \rightarrow RSSR$	
$RS^\bullet + RCH{=}CH_2 \rightarrow RCH{-}CH_2SR$	
C—Peroxide Formation	
$ROO^\bullet + RSH \rightarrow RS^\bullet + ROOH$	
$ROO^\bullet$ + H In $H \rightarrow In\ H^\bullet + ROOH$	
$ROO^\bullet + In\ H^\bullet \rightarrow$ Quinone Imide + ROOH	

on pumice) and in the use of a zinc sulfide on pumice aftertreat. It is also operated with a greater excess of air.

The air-inhibitor, air-caustic, and air-solutizer sweetening processes will be considered together because of their inter-relationships in principle.

The air-inhibitor process consists of simply mixing a low mercaptan content gasoline inhibited with a phenylenediamine type material with caustic and air. A portion of the sweetening takes place in the treater itself, but a significant amount occurs in subsequent storage. In connection with this sweetening in tankage, carryover of caustic to storage as a fairly stable haze is essential.

As in the sweetening processes discussed previously, oxidation of the tertiary mercaptans is very limited and the process is inapplicable to stocks containing a significant fraction of these types. As a number of references[8,16,18,19] point out, the sweetening reaction is far from simple. The reaction mechanism cited in Table 3 and discussed below are from Rampino and Gorham's paper.[16] The features to be noted are:

1—In the absence of caustic, the gasoline must form free radicals readily (cat cracked does, and can be inhibitor sweetened; straight-run gasolines peroxidize very slowly and are not amenable to air inhibitor treatment).

Amino phenol and hindered phenol inhibitors which suppress peroxide formation suppress sweetening.

Inhibitor is consumed during sweetening.

Sulfides and disulfides are formed.

Peroxides are formed.

2—In the presence of caustic only disulfides are formed.

Disulfides are formed by direct oxidation; the peroxide intermediate is not required.

Peroxides formed and dissolved in caustic yield disulfides (same action as O_2).

Inhibitor is consumed.

Rosenwald, while agreeing in part with these observations and conclusions reports that the over-all gasoline phase inhibitor sweetening reactor is:

$$-C{=}C- + O_2 + 3RSH = R{-}S{-}C{-}C{-}OH + RSSR + H_2O \quad \ldots (14)$$

and states that a hindered phenol inhibitor had no effect on the mercaptan oxidation.

Commercial air-inhibitor sweetening is probably a composite of these effects. The major adverse feature of inhibitor sweetening i. of course peroxide formation, with the consequent deterioration of stability and engine cleanliness.

As Rampino and Gorham point out, the data suggest that peroxide formation in inhibitor sweetening is largely determined by the type of gasoline and especially by the amount of mercaptans that are not extracted by caustic. Since the gasoline phase reaction inevitably involves peroxide formation and inhibitor consumption, promotion of the caustic phase reaction is desirable.

Rosenwald, working along related lines, has investigated the effect of improving the extraction of mercaptans into the aqueous phase by using a methanol-caustic reagent. Marked increases in sweetening, reductions in peroxide formation, and improvements in oxygen utilization were noted.

Disulfide yields increased to the level predicted by Equation 14. Disulfide yields considerably exceeded this level when the caustic phase predominated and the bulk of the mercaptan was, therefore, in this phase, and when the phenylenediamine type inhibitor was absent.

It thus appears that the gasoline

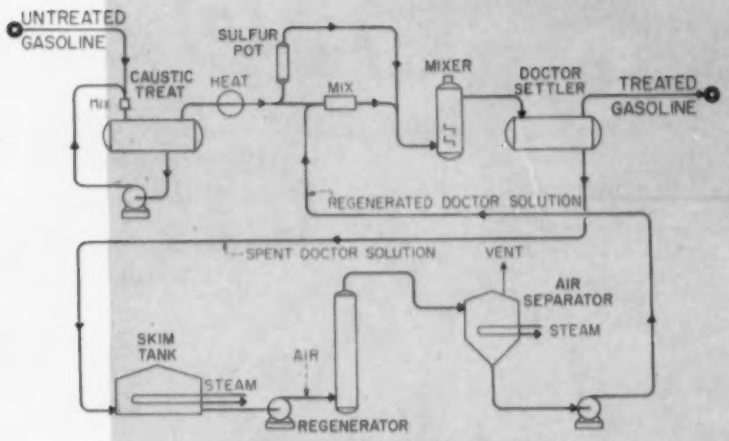


Fig. 6—**CONTINUOUS DOCTOR TREATING** suitable for a wide range of gasolines and mercaptan contents

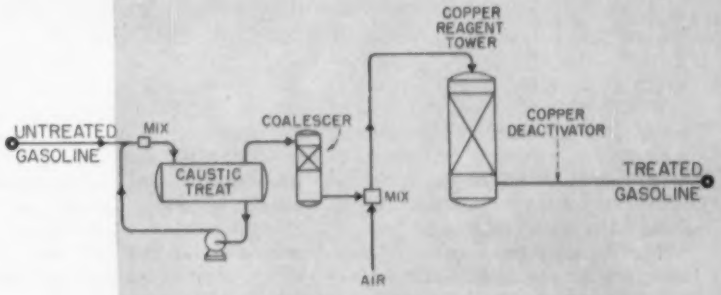


Fig. 7—**FIXED-BED COPPER** treater for mercaptan removal from straight-run stocks

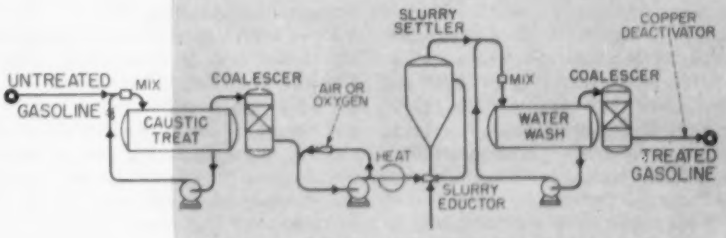


Fig. 8—**COPPER-SLURRY** treater for mercaptan removal

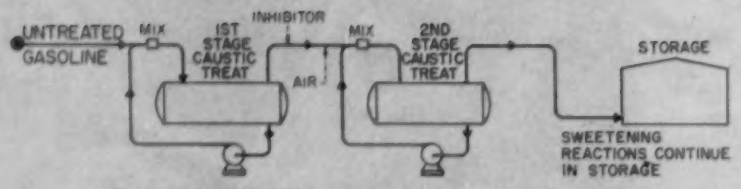


Fig. 9—**AIR-INHIBITOR** treater for mercaptan removal

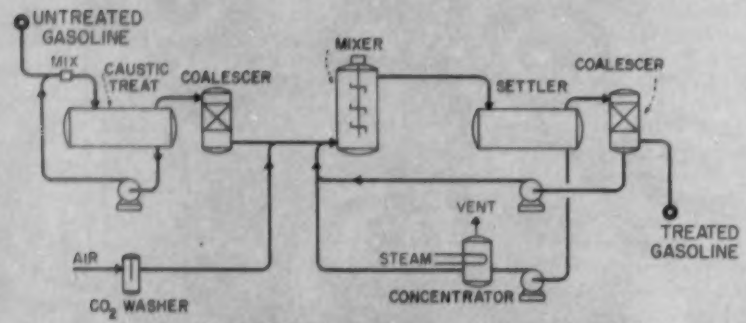


Fig. 10—**AIR-SOLUTIZER** treater for mercaptan removal from both straight-run and cracked stocks

phase inhibitor sweetening is in direct competition with the caustic phase mercaptide oxidation.

The air-solutizer process[10] came from similar reasoning based on extensive work in the field of air-regenerative solutizer processing which has been in successful commercial operation on both straight-run and cracked gasolines for two years.

Essentially this consists of contacting a lightly inhibited gasoline with a KOH-Solutizer solution and air in a turbo mixer or equivalent for a period of 2-20 minutes. The major reaction is direct oxidation to disulfides; octane number, lead susceptibility, stability and engine cleanliness are unaffected.

The process will provide satisfactory oxidation of all molecular weights and types of mercaptans in gasoline. It has also been established that NaOH and KOH will suffice as the alkaline phase when dealing with the more readily extracted and oxidizer mercaptans.

Figs. 9 and 10 indicate the essentials of air-inhibitor and air-solutizer treaters. The extreme simplicity of the air-inhibitor unit explains why this process has been increasingly used since its discovery in 1946, whenever the stocks to be treated can be satisfactorily inhibitor sweetened without degrading stability or cleanliness.

Numerous variants on the basic design have been employed, e.g., omission of prewash, variation in air injection point.

The air-solutizer process is somewhat more complex but possesses the advantages of being able to handle all stocks and of completing the sweetening in the unit, thus making the gasoline immediately available for blending and shipment with minimum storage.

Both processes are run at temperatures of about 80-120°F, pressures sufficient to prevent any gasoline vaporization or air pocket formation (25-50 psig) and reagent/gasoline circulation rates of about 0.1:1. Caustic concentrations ranging from 10-40° Bé are reported for inhibitor sweeteners, whereas air-solutizer units employ solutions similar to conventional solutizer plants. Carbon steel construction is satisfactory for both processes.

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Meet the Authors

Harry Walker

Ewing Kenney

Mr. Harry E. Walker, Chief Research Technologist at Shell Oil Co.'s Houston, Texas refinery, is a native of New York City. He received his B.S. and M.S. in Chemical Engineering from Columbia, joining Shell as junior technologist at Wood River, Ill., in 1941. Mr. Walker has also served in Shell's N. Y. Manufacturing-Development Dept. and the Wood River Alkylation Dept.

Mr. Ewing B. Kenney, Jr., is technologist in Shell Oil Company's Manufacturing-Technological Department, head office, New York. He is a native of Jefferson City, Missouri.

Mr. Kenney received his B.S. in Chemical Engineering from the University of Missouri before joining Shell in 1947 as a junior technologist at the Wood River, Illinois refinery.

4 Pressure-Hydrogen Treating

By MARSHALL SITTIG, Ethyl Corp.

UPGRADING naphtha under hydrogen pressure is of dual importance in today's chemical treatment of petroleum fuels because—firstly, the upgrading of naphtha by hydrogen reforming is in itself a chemical treatment process and, secondly, because it is a producer of hydrogen gas for other chemical treating operations.

The story of the upgrading of naphtha begins by answering the question, "Where does naphtha come from?" We are concerned with three general types of naphtha—virgin naphtha, cracked naphtha and coker naphtha. Virgin naphtha constitutes by far the greatest volume of available naphtha and is distilled directly from crude oil.

Next we take up the question, "What is naphtha?" Naphtha is basically defined by its distillation range, and Table 1 shows some of the extreme variations in hydrocarbon composition which can occur within the 200 to 400°F distillation range—the naphtha cut which is generally subjected to upgrading under hydrogen pressure.

As shown in Table 1, naphthalene or cycloparaffin contents range from 20 to 43%, aromatic hydrocarbon contents from 8 to 18% and paraffin hydrocarbon contents from 26 to as high as 65%. The main point to remember is that naphtha is an extremely loose term which does define an approximate hydrocarbon boiling range but which may encompass a wide variety of hydrocarbon compositions.

These hydrocarbon compositions are primarily of importance with regard to the effect they have on the potential of that particular mixture for use as a motor fuel. This, in turn, defines the necessity for upgrading naphthas under hydrogen pressure.

Next let's answer the question, "What about naphtha quality?" Table 1 also shows that virgin naphthas have clear or unleaded octane numbers which are very low, ranging from 30 to 60 in these examples—the same naphthas, incidentally, whose hydrocarbon composition we just discussed.

When these naphthas are mixed with the maximum permissible quantity of tetraethyllead (3cc/gal.), their qualities still fall far short of present-day standards for motor fuels—by 50-80 points. By leading these naphthas to the maximum, their octane ratings are improved by about 20 points in each case, but this is not enough.

So, the next question is, "What to do with naphtha?" One possibility is to divert the heavy ends of naphtha to jet fuels where there is no critical octane requirement. Aside from this possibility, there is the basic problem of octane improvement.

It is possible to take some of the light ends of naphtha and improve them by isomerization. With present knowledge of processing techniques and with present-day economics, however, there is little alternative but to upgrade or reform the major portion of the naphtha barrel under hydrogen pressure.

After considering the basic necessity for improvement of naphtha quality the next question is, "What about reformate quality?"

A typical virgin naphtha which had a clear octane number of 53 and only had a potential of being leaded to an octane number of 73 can be reformed under hydrogen pressure to give a clear octane number of 90 which can be leaded to 97. At the same time sulfur content is cut down to 1/400 of what it was before—from 0.08 to 0.0002.

Now that the benefits to be obtained from upgrading naphthas under hydrogen pressure have been discussed, the next item to consider is what is involved in today's catalytic reforming processes.

The simplified flow diagram shows the basic essentials of any of the dozen or more catalytic reforming processes available from various licensors today.

Naphtha charge joins a recycle hydrogen stream and is pumped through a fired coil in a furnace. Hot gaseous mixture passes through a bed of catalyst in a reactor, the product is condensed and the uncondensed gases containing from 60 to 90% hyrogen are recycled in part, also providing a net source of hydrogen.

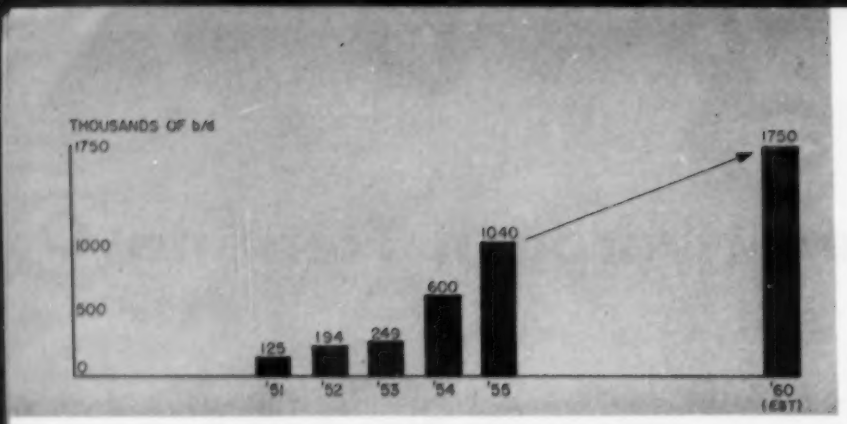
Recycled hydrogen is of the order of 2,000 to 6,000 cu. ft./bbl. of naphtha processed and the net hydrogen produced varies from 500 to 1,000 cu. ft./bbl., depending upon the catalyst and operating conditions employed.

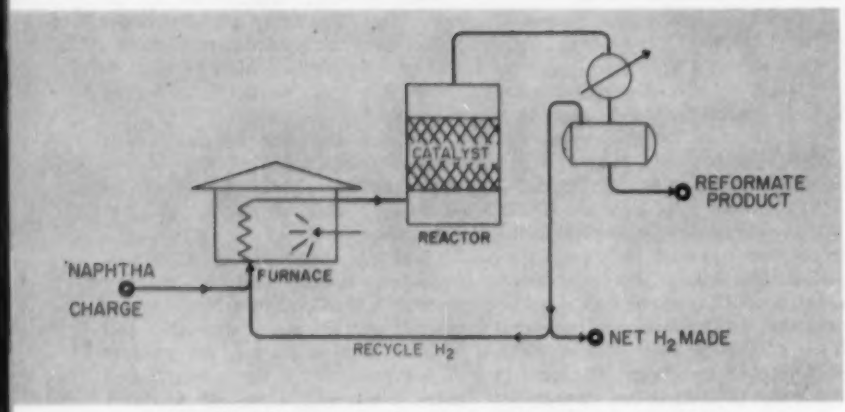
Hydrogen in the naphtha reforming process is recycled instead of drawing it off for use in other chemical processing for several reasons. Suppression of coke formation on the catalyst is the primary reason. Also, reforming in a hydrogen atmosphere removes sulfur, and reforming in a hydrogen atmosphere hydrogenates any unsaturated materials formed in the reaction so that they do not have a chance to form undesirable materials on the catalyst or in the product.

So much for the essentials of the process—why it must be done and how it is done. Now, consider the scale of operations and see what this means to the petroleum industry, or to the allied chemical process indus-

Table 1—Typical properties and compositions of straight-run petroleum naphthas

Crude Source	Gravity °API	Boiling Range, °F	Naphthenes vol. %	Aromatics vol. %	Paraffins vol. %	Sulfur wt. %	Octane Clear	Octane with 3cc TEL
Mid-Continent	54	240-370	43	8	49	0.02	36	61
Venezuela	49	250-385	43	23	34	0.03	51	73
Kuwait	54	240-355	20	15	65	0.09	30	53
Pennsylvania	47	214-335	29	11	60	0.07	43	65
Gulf Coast	58	202-395	56	18	26	0.02	59	79





BASIC ESSENTIALS of fixed catalytic reformers in simplified diagram

tries as suppliers to the petroleum industry, or as consumers of chemicals from the refinery.

The bar chart shows the tremendous upsurge in the installation of catalytic reforming units. First of all in thousands of barrels per day there is almost a ten-fold growth from 125,000 b/d in 1951 to over 1,000,000 b/d at the end of 1955, with a capacity estimated at 1.75 million b/d by 1960.

An obvious question is, "What does all this reforming mean to the chemical industry?"—in terms of catalyst consumption, aromatics production and net hydrogen availability.

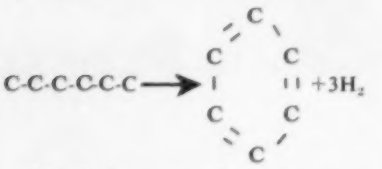
The first item of importance is catalyst consumption. One type of catalyst used in upgrading naphthas under hydrogen pressure contains 10% of molybdenum oxide on an alumina support. 1955 requirements for this type of catalyst are estimated at almost 14,000,000 lbs., which at a price of 60¢/lb., gives an estimated gross sales figure in excess of $8,000,000.

Catalysts of most current interest contain about ½% platinum metal on an alumina support. Requirements for new construction in 1955 are estimated at 2.5 million lbs., which at a price of $11.00/lb. indicates a $27,000,000 business.

In addition to catalyst requirements for new construction, spent platinum catalysts must be processed for platinum recovery and almost 6,000,000 lbs. of catalyst will be handled in this manner. Assuming a reprocessing charge of $4.00 /lb., this indicates an additional $23,000,000 worth of business or a total sales volume in the platinum catalyst field of about $50,000,000 in 1955.

Another important aspect is aromatics production—benzene, toluene and xylene. The table, left, shows a slow but steady growth in the production of these three aromatics from coal contrasted with a rapid and phenomenal growth in the production of these aromatic hydrocarbons from petroleum by reforming.

Now, let's look at the hydrogen picture. Catalytic reforming is a large hydrogen producer. It is basically a process for converting straight-chain low octane hydrocarbons into high octane aromatic hydrocarbons by dehydrogenation as shown below:



Net hydrogen produced by these reactions averages 500 cu. ft./bbl. of naphtha charged, and when multiplied by the million b/d charge rate, the hydrogen availability figure from catalytic reforming is 500,000,000 cu. ft./day at the end of 1955. This hydrogen is available in many locations for over-the-fence pipeline supply to consuming units at fairly high purity (70-90%) and under fairly high pressure (200-700 psig).

What of the future? Indications are that in the next few years naphtha will be 100% subjected to hydrogen reforming in order to meet market octane requirements. (Total naphtha amounts to about 20% of crude oil.) The by-product hydrogen from naphtha upgrading will be vital:

1—For ammonia manufacture (some 11% of U. S. Ammonia is already made from this source) and

2—For hydrogen treating in the refinery by processes such as those which will be described in another article in this symposium (see page 000).

Aromatics production continues to grow and the catalyst demand is huge.

The basic result of all this catalytic reforming is the production of top octane motor fuels which will be obtained through severe reforming plus the maximum allowable use of tetraethyllead.

Production of benzene, toluene, and xylene

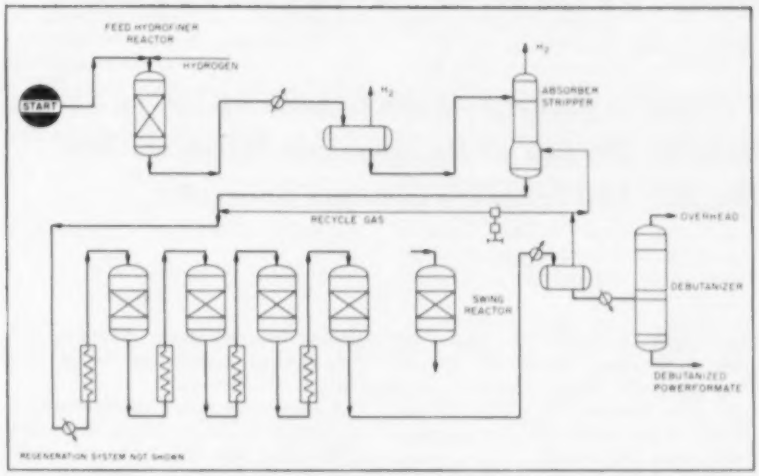
Millions of gallons in	1955	1960	1975
From coal	269	281	311
From petroleum by reforming	286	437	1060

Meet the Author

Marshall Sittig

Mr. Marshall Sittig, with Ethyl Corp. in New York City, was born in Oak Park, Ill. He received a B.S. in Chemical Engineering from Purdue University, doing some graduate work in chemistry at Purdue before "I ran out of money." He worked with Du Pont for seven years.

After Du Pont, Mr. Sittig worked for the Chrysler Corp. Engineering Division in Detroit. He has been with Ethyl Corp. since 1951, first in Detroit and currently in New York.



NEW FIXED-BED CATALYTIC REFORMING process announced by Esso Research & Engrg. Co.

Powerforming Is No. 14

LATEST entry in the catalytic reforming derby, Esso Research & Engineering Co.'s fixed-bed cyclic process, has been named "Powerforming." This means there are now 14 different catalytic reforming processes in use today.

With three Powerformers now in operation and 13 planned at Standard Oil Co. (N.J.) affiliates in the U.S. and abroad, total investment in units using the new process are estimated at $60 million.

The three now onstream are: a 3000 b/d unit at Esso Standard Oil Co., Baltimore, Md.; 2000 b/d unit at Imperial Oil Ltd., Edmonton, Atla.; and a 2500 b/d unit at Carter Oil Co., Billings, Mont. The Baltimore unit was the pilot-commercial test plant for the process.

Largest new unit planned will be 20,000 b/d installation at Esso Standard's Bayway refinery, Linden, N. J. Others definitely scheduled are: 8000 b/d at Imperial Oil Ltd., Montreal, Que.; 5600 b/d at Stanic Industria Petrolifera, Bari, Italy; and 1000 b/d at Esso Standard Italiana, Trieste.

The features of the Powerforming process are a new platinum catalyst and a newly-developed catalyst regenerating technique. Esso Research says the catalyst contains "relatively small quantities of platinum," and that the new process is quite similar to Ultraforming— a platinum type process developed by Standard Oil Co. (Indiana). This latter technique grew out of fixed-bed hydroforming, which was developed by Esso Research's predecessor company, Standard Oil Development Co., in conjunction with Indiana Standard and M. W. Kellogg Co.

Esso Research will license its new catalyst to refiners for use in other processes. The material is being manufactured by Davison Chemical Co., a division of W. R. Grace & Co. Davison also makes the platinum-on-silica-alumina base catalyst used in Atlantic Refining Co.'s Catforming process. Esso Research officials point out, however, that the advantages of the Powerforming process can be obtained only when using the catalyst with its new regenerating technique.

As illustrated in the flow chart, the process uses four, five, or six reactors —one of which serves as a "swing" reactor for any one of the primary reactors during the regeneration cycle. Any single reactor can run from five to fifteen days.

This new process is not unique in being regenerative. Several of the commercially available fixed-bed catalytic reforming processes regenerate catalyst, and any of them could potentially add a swing reactor to permit regeneration without a shutdown.

Yields of up to 100-octane motor fuel from heavy Arabian crude oils have been indicated by pilot plant runs, as shown in the accompanying table. Such results compare favorably with recent operating reports of other catalytic reforming processes operating on feedstocks from Middle East crudes.

These are regarded as good tests of reforming performance, because Middle East crudes have high paraffin percentages and are the most difficult to reform.

No additional technical details on the process have as yet been disclosed.

Powerforming Results with Four Types of Feed

Crude source	Light Arabian	Heavy Arabian		Mixed Louisiana	Heavy West Texas
Feed stock inspections:					
Gravity, °API	61.9	54.0		60.3	50.6
Sulfur, wt.—%*	0.03	0.07		0.005	0.20
CFR-R octane, clear	39	29.7		53	46.1
Distillation:					
10%, °F.	216	276		205	288
50%, °F.	241	326		231	308
90%, °F.	282	370		293	350
Product:					
Research octane, clear	95	95	100	98	98
plus 3 cc.	100.5	100	103	103	102
Motor octane, clear	85.5	85	88.5	88	88
plus 3 cc.	92	91.5	93.5	93	92
Yields:					
C_5+, vol.-%	72.5	77	69	72.5	81
C_4, vol-%	10.5	9	11.5	10.5	6.5
C_1-C_3, wt-%	12.5	12	16.5	12	8.5
H_2, wt-%	1.4	1.0	0.7	1.8	1.8
H_2, SCF/B	680	510	350	880	930

*Before Hydrofining.

Soyez les Bienvenus à Montréal

Welcome to Montreal. If you're going up for the 21st Mid-Year Meeting of the American Petroleum Institute, May 14-17—here's what you can expect

YOU'LL FIND the welcome sign out all over downtown Montreal. Les habitants like visitors—they're proud of their city's heritage, cosmopolitanism, and charm.

And cosmopolitan Montreal is a charming city. The influences of four cultures have shaped the 313-year-old metropolis into a mellow but sparkling giant. Its business community has a conservative British flavor, its shopping district huge U. S. style department stores. Canadian influence shows in maple leafs, ice hockey, and a northern hardiness.

But probably Montreal will strike you as European. It bears prominent signs of its French heritage. Two-thirds of its citizens are French speaking. Much of its architecture has a continental look. Trees are plentiful. And the daily dress—including English tweeds, berets, ski parkas, Scotch plaids, and fur caps—is another reminder of Europe.

All this means that Canada's largest city is a good place to visit. There's a lot to see and do. The map on the facing page will help you get around, the adjoining list of attractions shows you what to expect.

Montreal, like Manhattan, is built on an island. The St. Lawrence washes its shores as it sweeps beneath the thirteen bridges connecting the city with the mainland.

Entry is simple. Both the Canadian Pacific and the Canadian National Railways have downtown terminals. Dorval airport is a half hour away, on the southwestern shore. Entry regulations are no problem—passports are not required from U. S. citizens. A simple statement of your business in Canada and a declaration of any unusual baggage will satisfy Customs. If you anticipate customs difficulties, get clarification from the Customs Division, Department of National Revenue, Ottawa.

Here's how to make the most of your Montreal visit:

Do you like good food? In Montreal it's plentiful and relatively inexpensive. The cuisine is almost as varied as the restaurants. Supper and night clubs are plentiful. Steaks are one of the local specialties. Try the Windsor Steak House, Moishe's, or, if you like atmosphere, the Tzigane Room of the Bucharest. For sea food, don't miss Desjardins.

Most of the city's good restaurants, and the other nighttime attractions, are downtown. This area is shown on the map. It lies at the foot of Mount Royal Park, the city's famous landmark. You'll find the 700-ft. high retreat useful for getting your bearings. A trip to the top should be a must. However, you'll have to walk, or go by horse and carriage—cars are kept out to preserve the park's character.

Like the night life? Montreal has its Stork Club, its El Morocco, its Bal Tabarin. The shows are long, the liquor, like the food, moderately priced. Supper and night clubs are available for every occasion. The Penthouse and the Ritz Cafe are *in-time*, the Harlem style Montmartre and the Bellevue Casino loud and lively. At the Bellevue, shows are two and a half hours long and small bottles of beer cost thirty-five cents.

If the present Montreal administration has washed some of the spice from the city's night life perhaps it has been indirectly responsible for the steady stream of top entertainers now appearing locally.

Montreal is a regular stop for touring theater groups. The best of New York's Broadway shows, and the best international musical, theater and ballet groups can be seen on the local stages.

The theaters serving the city's 1.4-million moviegoers show the latest from the world's film capitals. French films, naturally, are plentiful. The ultra modern St. Denis, the Imperial, a Cinerama theater, and Her Majesty's, the city's traditional live auditorium, are among the most important theaters.

Do you plan to shop? In Montreal, it's a three-part operation for visitors. There's a main shopping district, a French section shopping district, and a high fashion district. Don't expect to find bargains in any of them. Dollars in Canada stretch no farther than their U. S. cousins.

Canadian currency follows the U. S. systems. The dollars are at about par. The actual bills and coins, of course,

Montreal's Attractions for Sightseers and Shoppers

1—Historical wax museum
2—St. Joseph's Oratory (cathedral)
3—University of Montreal
4—Mount Royal Park
5—The Forum (arena)
6—Her Majesty's Theatre
7—Holt Renfrew's (department store)
8—Ritz-Carlton Hotel
9—Berkeley Hotel
10—Ogilvy's (department store)
11—Hotel de La Salle
12—Windsor Hotel
13—Central bus terminal
14—Laurentian Hotel
15—Canadian National RR station
16—Queen's Hotel
17—New Carleton Hotel
18—St. James Cathedral
19—Canadian Pacific RR station
20—Central airline terminal
21—Sheraton Mt. Royal Hotel
API meeting headquarters
Montreal tourist bureau
22, 23, 24, 25, 26—Department stores:
Simpson's, Eaton's, Birks,
Morgan's, Dupuis Freres
27—La Fontaine park
28—McGill University
29—Art Museum
30—Te Botanical Gardens
31—Bonsecours Market

are different. Though practically all stores will accept U. S. currency, you may find it less confusing to use Canadian money.

The main shopping district, along St. Catherine St. West, is practically indistinguishable from its U. S. counterparts. Both merchandise and prices are similar. The big department stores, Olgivy's, Eaton's, Simpson's, and Morgan's, are within walking distance of each other.

East of St. Laurent St. the predominantly French part of the city offers less concentrated shopping facilities, but somewhat lower prices. API visitors should find rewarding shopping there.

The high fashion district is centered around Mountain St. and Sherbrooke St. West. Clustered near Holt Renfrew's is an assortment of continental style "exclusive shops."

Are you a sightseer? Montreal has more than it's share of attractions. Contrast among them is strong. Every morning the Bonsecours market, near the famous Notre Dame cathedral is crowded with farmers and other suppliers from the local countryside selling their produce to Montreal's consumers. Colorful French, picturesque costumes and the ritual of the classic marketplace contribute to a vivid scene.

Scarcely a mile away, on stately Sherbrooke St. West, the fine collection of the city's big Art Gallery is on permanent display. Sprawling a few blocks east, McGill University forms a city within a city, offering daytime exhibitions, nighttime cultural activities. The French Catholic Université de Montréal is just across Mt. Royal park. Nearby, you can see history in wax at the Historical Museum. Hotel literature and any of the city's eight or so newspapers will keep you informed on current attractions.

Montreal Miscellany Canada's Imperial gallons are about one-fifth larger than the U. S. gallon. But the price of gasoline is generally higher.

- Trolley fares are two for-a-quarter.
- Use Canadian stamps only. Rate: 5 cents per ounce.
- You can take up to $200 worth of Canadian purchases back to the U. S. duty-free. The liquor limit is one wine gallon. All Canadian purchases must be declared on leaving Canada.

New Process Design Methods for . . .

Optimum Bubble-Cap Tray Design

PART III—DESIGN TECHNIQUE

By WILLIAM L. BOLLES, Mgr. of Process Design
Monsanto Chemical Co., Texas City, Texas

THE previous articles in this series have covered tray dynamics and design standards. These represent the tools of tray design, but it is still necessary to know how to use them effectively. It is the purpose of this article to develop design techniques by which it is possible to achieve the optimum tray design for any specific application.

Principal Design Variables

Part II established design standards for most of the variables of bubble-cap tray design. These design standards were summarized in Table 6. However, there still remain nine principal independent variables which must be fixed in order to complete the tray design. These variables are listed in Table 7.

The object of tray design technique is to determine the optimum combination of these nine variables. This optimum is that combination which:

1—Insures required performance under design conditions.

2—Provides required flexibility to handle reduced loads.

3—Achieves the above at minimum cost.

Selection of Tray Type

The most suitable tray type depends on the liquid/vapor ratio to be handled. Table 8 lists eight recommended tray types in order of increasing liquid/vapor capacity. Sketches of these trays are given in Fig. 21 (Part II).*

In addition to liquid/vapor ratio, the tower size also affects optimum tray type. Based on experience it has been found that the guide for selection of tray type given in Table 9 will serve as the best starting point.

The ranges given in Table 9 are approximate and are intended for tentative selection only. The final selection of tray type should be based upon the results of complete tray dynamic calculations for the specific application.

Downcomers and Weirs

Segmental downcomers are designed with the aid of the segmental downcomer design chart, Fig. 31. Here given as a function of weir length are downcomer width and downcomer area.

A few notes on practical ranges of downcomer dimensions may be helpful. In the design of downcomers for cross-flow trays the optimum weir length is usually 60-75% of tower diameter. In segmental downcomers for double-pass trays, the optimum weir length is usually 50-60% of tower diameter. The optimum width of center downcomers for double-pass trays is usually 8-12 in.

The heights of overflow weirs are determined on the basis of providing adequate dynamic seal, following the recommended ranges given in Table 6. It is recommended that all overflow weirs be specified as adjustable.

Analysis of Tray Areas

The area on a bubble-cap tray may be classified into four categories as shown in Fig. 32. The allocated cap area is that area allocated to the bubble-caps, sometimes referred to as the active tray area. This is defined as the

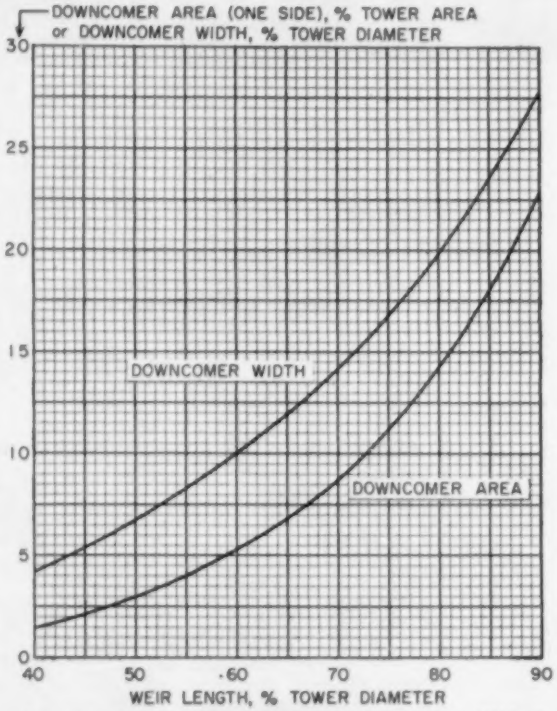


Fig. 31—**SEGMENTAL DOWNCOMER DESIGN CHART**

*PETROLEUM PROCESSING, March 1956, pp. 82-95.

Table 7—Principal tray design variables

1—Tower diameter
2—Tray spacing
3—Tray type
4—Downflow area
5—Bubble-cap size
6—Cap spacing
7—Cap skirt height
8—Overflow weir height
9—Cap stepping

Table 8—Recommended tray types*

(Arranged in order of increasing capacity for liquid/vapor ratio)

1—Reverse-flow
2—Reverse-flow, with stepped caps
3—Cross-flow
4—Cross-flow, with stepped caps
5—Double-pass
6—Double-pass, with stepped caps
7—Cacade double-pass
8—Cascade double-pass, with stepped caps

*See Fig. 21, Part II, PETROLEUM PROCESSING, March, 1956, pg. 82 for sketches of tray types.

Table 9—Guide for tentative selection of tray type

Estimated Tower Dia. ft.	Range of liquid capacity, GPM — Reverse Flow	Cross Flow	Double Pass	Cascade Double-Pass
3	0-30	30-200		
4	0-40	40-300		
6	0-50	50-400	400- 700	
8	0-50	50-500	500- 800	
10	0-50	50-500	500- 900	900-1400
12	0-50	50-500	500-1000	1000-1600
15	0-50	50-500	500-1100	1100-1800
20	0-50	50-500	500-1100	1100-2000

Table 10—Approximate distribution of areas as % of tower area

(Allocated cap area is determined by difference)

Tower Diameter ft.	Downflow Area — Cross Flow	Double Pass	Liquid distribution area — Cross Flow	Double Pass	Cascade Double	End Wastage
3	10-20	——	10-25	——	——	10-30
4	10-20	——	8-20	——	——	7-22
6	10-20	20-30	5-12	15-20	——	5-18
8	10-20	18-27	4-10	12-16	——	4-15
10	10-20	16-24	3- 8	9-13	20-30	3-12
12	10-20	14-21	3- 6	8-11	15-25	3-10
15	10-20	12-18	2- 5	6- 9	12-20	2- 8
20	——	10-15	——	5- 7	9-15	2- 6

Table 11—Bubble-cap size and slot area

(Based on standard bubble-caps)

Nominal cap size, in.	Ratio slot/allocated cap area — $\gamma = 0.25$	$\gamma = 0.3125$	$\gamma = 0.375$	$\gamma = 0.50$
3	0.39	0.35	0.32	0.27
4	0.36	0.33	0.30	0.25
6	0.29	0.26	0.24	0.20

agglomeration of hexagonal areas surrounding the bubble-caps, the width of each hexagon equal to the cap pitch.

The liquid distribution area includes those areas between the allocated cap area and the overflow weir on one side, and the downflow baffle on the other. One area is for inlet distribution, and the other for outlet disengaging. In the case of cascade trays, this area also includes the inactive space on either side of intermediate weirs.

The downflow area includes that area on both sides of the tray. In the case of double-pass trays, this area includes, of course, the center as well as side downcomers.

The remaining space around the sides of the tray is the end wastage area, which consists of that area between the allocated cap area and the tower wall.

The distribution of area according to these four classifications varies with the tower diameter, type of tray, and other factors. However, on the basis of experience certain practical ranges have been determined, and these are summarized in Table 10. Here given are ranges of

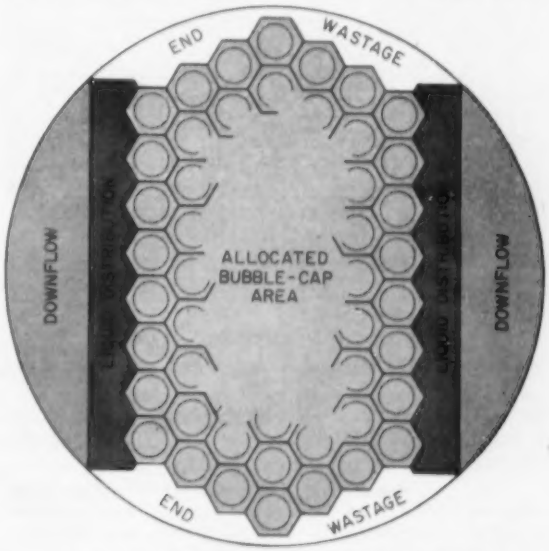


Fig. 32—**CLASSIFICATION OF TRAY AREA**

downflow, liquid distribution, and end wastage areas. The allocated cap area is obtained by difference.

For well designed trays, the allocated cap area frequently ranges from 60 to 70% of tower area. For estimating purposes, it is recommended that the allocated cap area be taken at 60% of the tower area.

Bubble-Cap Size and Arrangement

Small bubble-caps provide relatively more slot area. This is demonstrated in Table 11 where the ratio of slot to allocated cap areas is shown for the three standard bubble-cap sizes at the four standard cap spacings.

Small bubble-caps also provide for more flexible arrangement and permit less end wastage and liquid distribution areas. This is especially true in the case of small columns.

There are two advantages of large bubble-caps. One is that they give lower liquid gradients. The other is that they are cheaper for the same amount of tray area. However, when total tray costs are developed on the basis of equal slot area and proportionate cap spacing, the costs are practically the same for all three standard cap

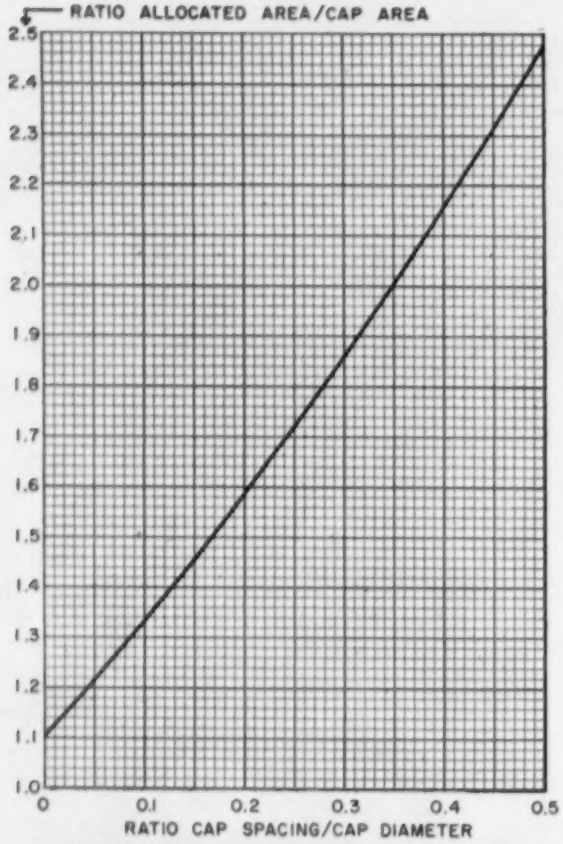


Fig. 33—**CORRELATION OF ALLOCATED AND CAP AREAS**

sizes. This is demonstrated by the following figures developed for standard caps spaced at 25% of cap diameter:

Cap Size in.	Relative Tray Cost per Unit Tray Area	Ratio Slot to Allocated Cap Area	Relative Tray Cost per Unit Slot Area
6	1.0	0.29	3.5
4	1.2	0.36	3.4
3	1.35	0.39	3.5

Equilaterial triangular cap pitch is recommended. Other pitches may be used, but they provide no particular advantage. Furthermore, it is much more difficult to calculate liquid gradient for odd pitches.

Cap spacing affects the liquid flow area and the liquid gradient. Wider cap spacings reduce liquid gradient, but require greater allocated cap areas. The correlation between allocated and cap areas is given in Fig. 33. The cap area is defined as the cross sectional area contained within the outside diameter of the cap.

High skirt clearance permits a reduction in liquid gradient Low skirt clearance, on the other hand, favors low liquid hold-up. The recommended range of skirt clearance is given in Table 6 (Part II).

Some designers try to improve vapor distribution by blanking off some of the caps on the tray, or intentionally designing caps with high pressure drop. These measures do improve vapor distribution, but they have the disadvantage of increasing pressure drop and reducing tray capacity.

It is quite possible to obtain satisfactory vapor distribution and still retain a tray with low pressure drop and high capacity by employing other techniques. One is to decrease liquid gradient by (1) employing wider cap spacings, or (2) providing higher skirt clearances. Another is to employ intermediate weirs (cascade trays). Still another is to step the caps at several levels.

Bubble-Cap Stepping

Vapor distribution can be greatly improved by attempting to match cap elevations to the expected liquid gradient. The only pitfall is that cap stepping can be overdone, producing the effect of reversed liquid gradient at low liquid loads.

It should be recognized that cap stepping adds somewhat to the cost of the tray. However, this measure is frequently worth the slight additional cost.

The bubble-caps can be stepped at two or more cap elevations by choosing caps with different riser heights from Table 4 (Part II). The stepped sections are not necessarily divided into equal numbers of rows. In the case of double-pass trays, dividing the stepped rows equally would result in greater liquid gradient across the section next to the side weirs because of the curvature of the tower wall. Instead, the stepped sections should be divided so as to equalize the liquid gradient across each of the stepped sections.

In the stepping of caps on cascade trays, it is important that allowance be made for the fact that the liquid height over intermediate weirs is different from that over end weirs. The setting of the weirs and the stepping of caps on cascade trays should be made on the basis of equalizing dynamic submergences.

Tray Layout

The design standards summarized in Table 6 (Part II) should be followed in laying out bubble-cap trays.

Tray layout may be greatly facilitated by employing the four bubble-cap layout charts, Fig. 34-37, which cover cap spacings of 25, 31, 37, and 50% of cap diameter. These charts may be used to lay out all trays, regardless of tray type, tower diameter, bubble-cap size, or bubble-cap spacing.

The bubble-cap layout charts are intended to be used in conjunction with an auxiliary piece of tracing paper. After selection of the cap size and spacing, a circle for the column diameter is drawn on the tracing sheet in accordance with the appropriate scale indicated on the layout chart. Also on the tracing sheet are sketched tentative locations for weirs and downcomers.

The tracing sheet is then superimposed on the layout chart, while shifting orientation so as to achieve maximum utilization of allocated cap areas. The downcomers and weirs may also be adjusted to give the most efficient arrangement. After a satisfactory arrangement is obtained, the maximum number of bubble-caps may be easily counted.

For large towers, it is quite practical to develop the tray layout on the basis of a half, or even a quarter of the tray.

Recommended Tray Design Procedure

The following procedure is recommended for development of optimum tray design:

1—**Make tentative selection of bubble-cap.** Selection should be made from one of the standard bubble-caps given in Table 4 (Part II).*

2—**Calculate minimum slot area.** The required slot

*Petroleum Processing, March, 1956, pp. 82-95.

area for fully-loaded slots is most conveniently determined by use of Fig. 3 (Part I).*

3—**Select cap spacing.** One of the standard spacings should be selected, either 25, 31, 37, or 50% of cap diameter.

4—**Determine required allocated cap area.** This is determined by dividing the required slot area by the appropriate factor from Table 11.

5—**Estimate tower size.** For this purpose assume the allocated cap area is approximately 60% of the total tower area.

6—**Select tray type.** This is done on the basis of the estimated tower size and liquid load by use of Table 9.

7—**Reconsider cap selection.** In view of the estimated tower size, it may appear advisable to change the cap size (refer to Table 6, Part II). If cap size is changed, re-estimate slot and allocated cap areas, repeating Steps 2-4.

8—**Estimate distribution of tray areas.** Use Table 10 as a guide, together with Fig. 31 for a more accurate determination of segmental downcomer areas. Compute allocated tray area by difference.

9—**Re-estimate tower size.** The required tray area is re-estimated by dividing the required allocated cap area by the estimated ratio of the allocated to the tower area.

10—**Select tray spacing.** This is done in accordance with the recommended ranges in Table 6 (Part II), or other limiting factors.

11—**Lay out first tray.** The first tray is laid out using the appropriate tray layout chart, Figs. 34-37. The number of bubble-caps provided should be counted to verify that the required slot area is provided.

12—**Calculate tray dynamics for first layout.** This is done using the relations developed in Part I.

13—**Compare tray dynamics with standards.** This comparison is made with the standards given in Table 6 (Part II).

14—**Develop improved layout.**— This is done on the basis of the tray dynamics resulting from the first layout by variation of one or more of the principal tray design variables listed in Table 7.

15—**Repeat until satisfactory layout is obtained.**

The technique of squeezing maximum capacity into minimum tray area is based on the most efficient utilization of each of the four area classes shown in Fig. 32. Theoretically, this is achieved when all clearances are pushed to the recommended limits, and all tray dynamic variables are bottle-necked simultaneously. Under these conditions each of the four tray area classifications are squeezed to the absolute minimum.

For example, the minimum number of bubble-caps are employed so as to push the slot opening to 100% of slot height. The caps are spaced as close to the tower wall as possible, and as close together as can be done without exceeding the upper limit of vapor distribution ratio.

Smaller caps are used if necessary for more efficient cap arrangement. In order to permit closer cap spacings, skirt clearance is increased to reduce liquid gradient, and the caps are stepped to compensate for the remaining liquid gradient.

The downcomers are reduced in size until one or more limits are reached involving liquid height in downcomers, downcomer residence time, or liquid throw over weirs.

*Petroleum Processing, Feb. 1956, pp. 64-80.

The tray type is also changed, if advantageous. In this manner the tower diameter may be successively reduced in size until the entrainment reaches the maximum allowed limit, or a combination of other tray dynamic factors show that the absolute minimum tower size has been achieved.

Hints and Kinks

Trays to Study. In all cases it is recommended that at least two trays be studied: the top tray and the bottom tray of the tower. This is recommended because the liquid and vapor loads are usually sufficiently different on these trays to make individual checking advisable.

Sometimes it is also advisable to study the trays immediately above and below the feed, or side drawoff, if there is sufficient variation in loads at these points.

In the case of double-pass trays, it is necessary to study both side and center downcomer trays.

If more than one tray design is used in a given tower, it is also advisable to check the tray immediately above and below the design change.

Loads to Study. Obviously the tray should be studied at the maximum anticipated vapor and liquid loads. After a satisfactory tray arrangement is developed, it is also important to check the tray performance under conditions of minimum anticipated loads. In addition, it may be advisable to check tray performance under any unusual operating conditions which are anticipated.

Designing for Load Variations. Bubble-cap trays provide exceptionally wide flexibility, and a single tray design is capable of handling wide variations in loads.

However, some cases are encountered in which liquid and vapor loads in different sections of the tower may be so different as to make a single tray design for use throughout the column inadvisable.

For these cases there are several possible solutions. One is to blank off some rows of caps on the trays in the column where the lower vapor loads are anticipated. The weirs on these trays may be raised, if necessary.

Another means is to design entirely different trays for different sections of the column, but all based on the same tower diameter.

Still another expedient is to vary the column diameter, employing entirely different tray designs for the different sections.

Judging Optimum Design. In the judging of optimum tray design, it should be remembered that the smallest column diameter is not necessarily the cheapest tray. It has been pointed out previously that small bubble-caps may add to the tray cost.

It has also been brought out that complicated tray types are more costly. Furthermore, it should be remembered that the length of the liquid path affects the tray efficiency. Finally, tray spacing affects column costs.

It should be apparent, then, that the real criterion for optimum tray design is the achievement of minimum installed tray cost per theoretical plate. If sufficient data and time are available, this criterion may be employed to achieve the very best tray design.

Next month, in the final part of his article on bubble-cap tray design, Mr. Bolles gives a sample numerical calculation for a design problem to illustrate the principles of Parts, I, II, and III.

For Bubble-Cap Layout Charts, see next four pages . . .

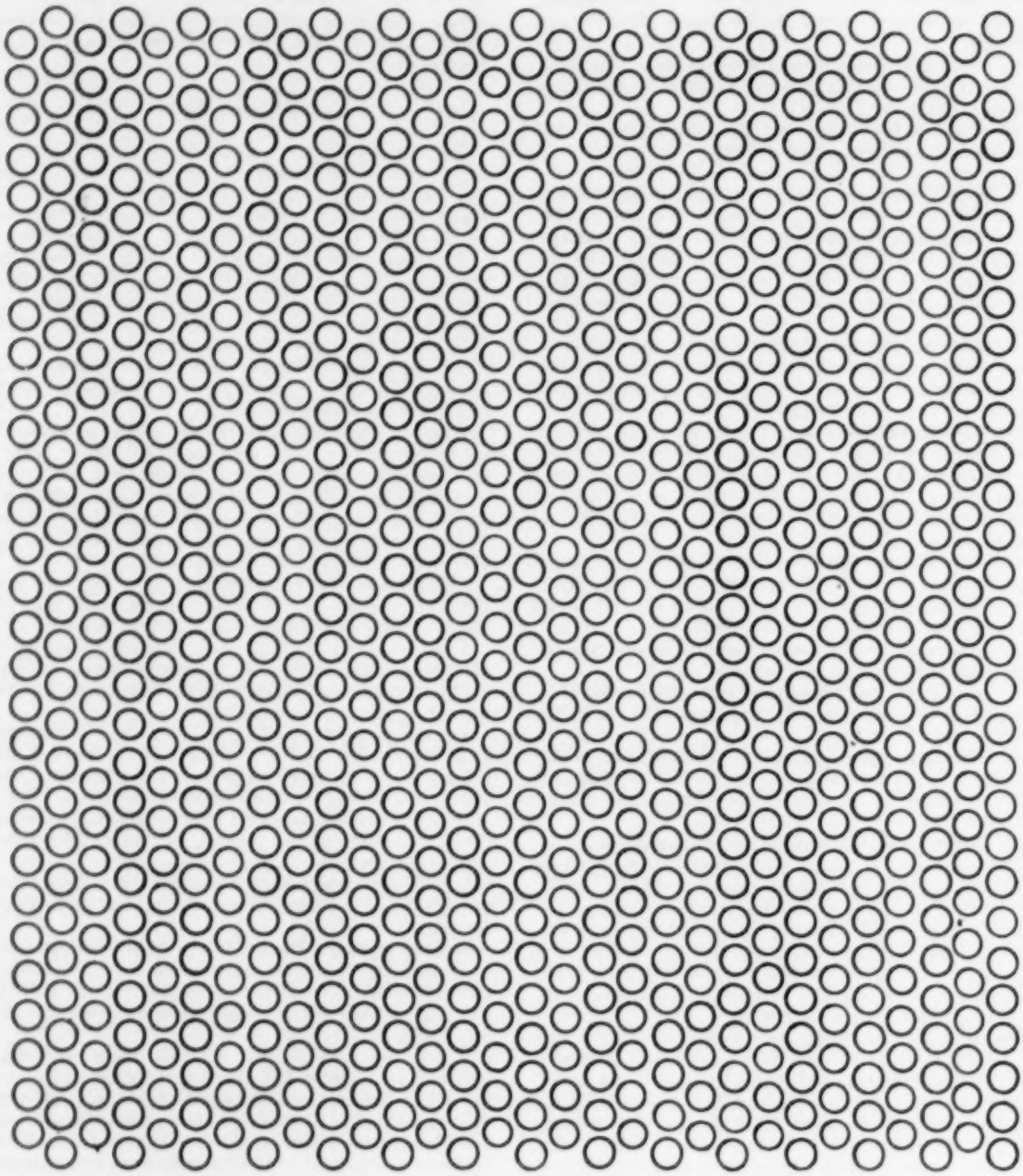

DIRECTION OF LIQUID FLOW
SCALES: FOR 3 IN. CAPS, USE 1 IN. = 15 IN.
0 10 20 30
FOR 4 IN. CAPS, USE 1 IN. = 20 IN.
0 10 20 30 40
FOR 6 IN. CAPS, USE 1 IN. = 30 IN.
0 10 20 30 40 50 60

Fig. 34—**BUBBLE-CAP LAYOUT CHART—CAP SPACING 25% CAP DIAMETER**

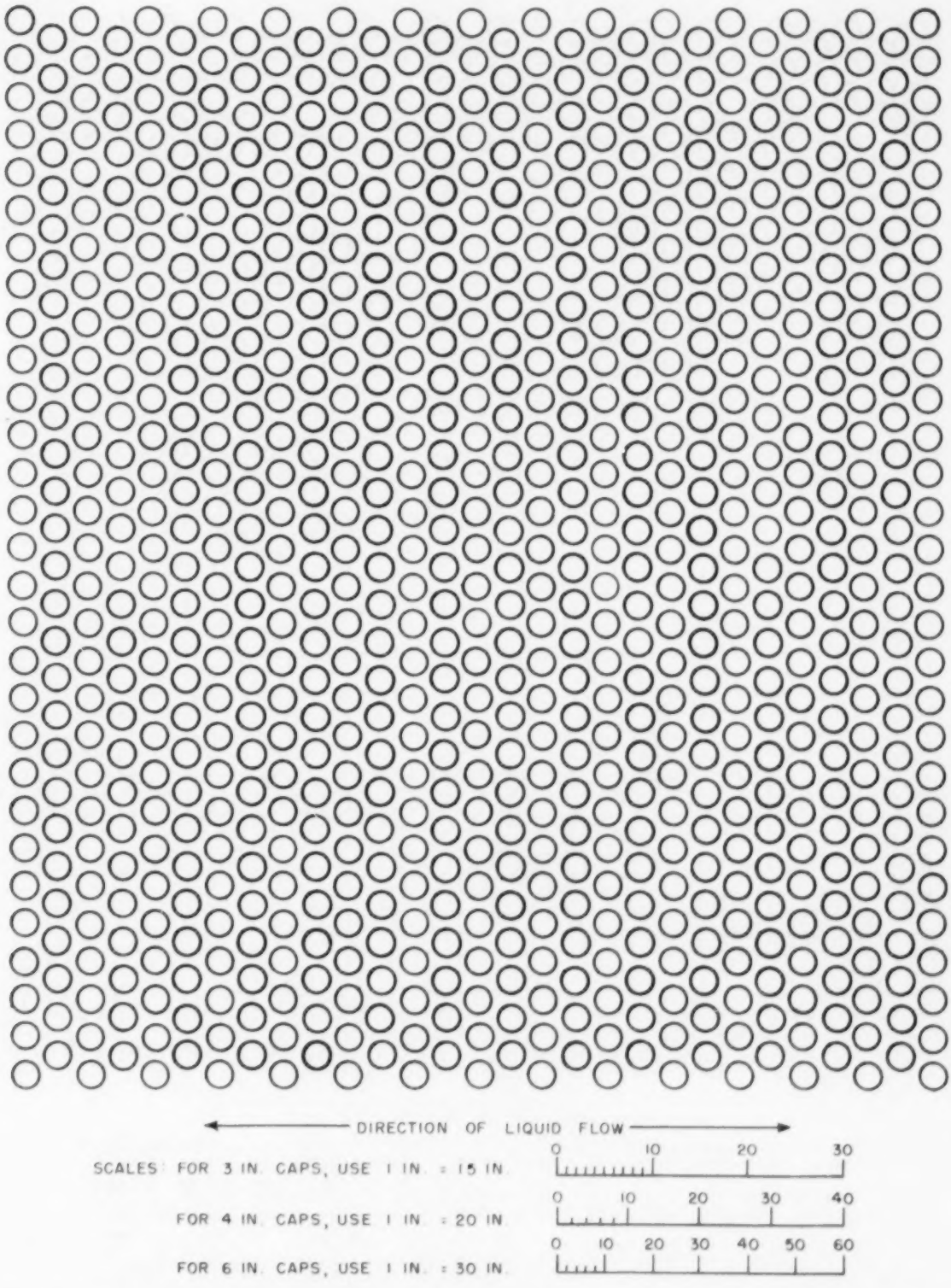

DIRECTION OF LIQUID FLOW
SCALES: FOR 3 IN. CAPS, USE 1 IN. = 15 IN.
0 10 20 30
FOR 4 IN. CAPS, USE 1 IN. = 20 IN.
0 10 20 30 40
FOR 6 IN. CAPS, USE 1 IN. = 30 IN.
0 10 20 30 40 50 60

Fig. 35—**BUBBLE-CAP LAYOUT CHART—CAP SPACING 31.25% CAP DIAMETER**

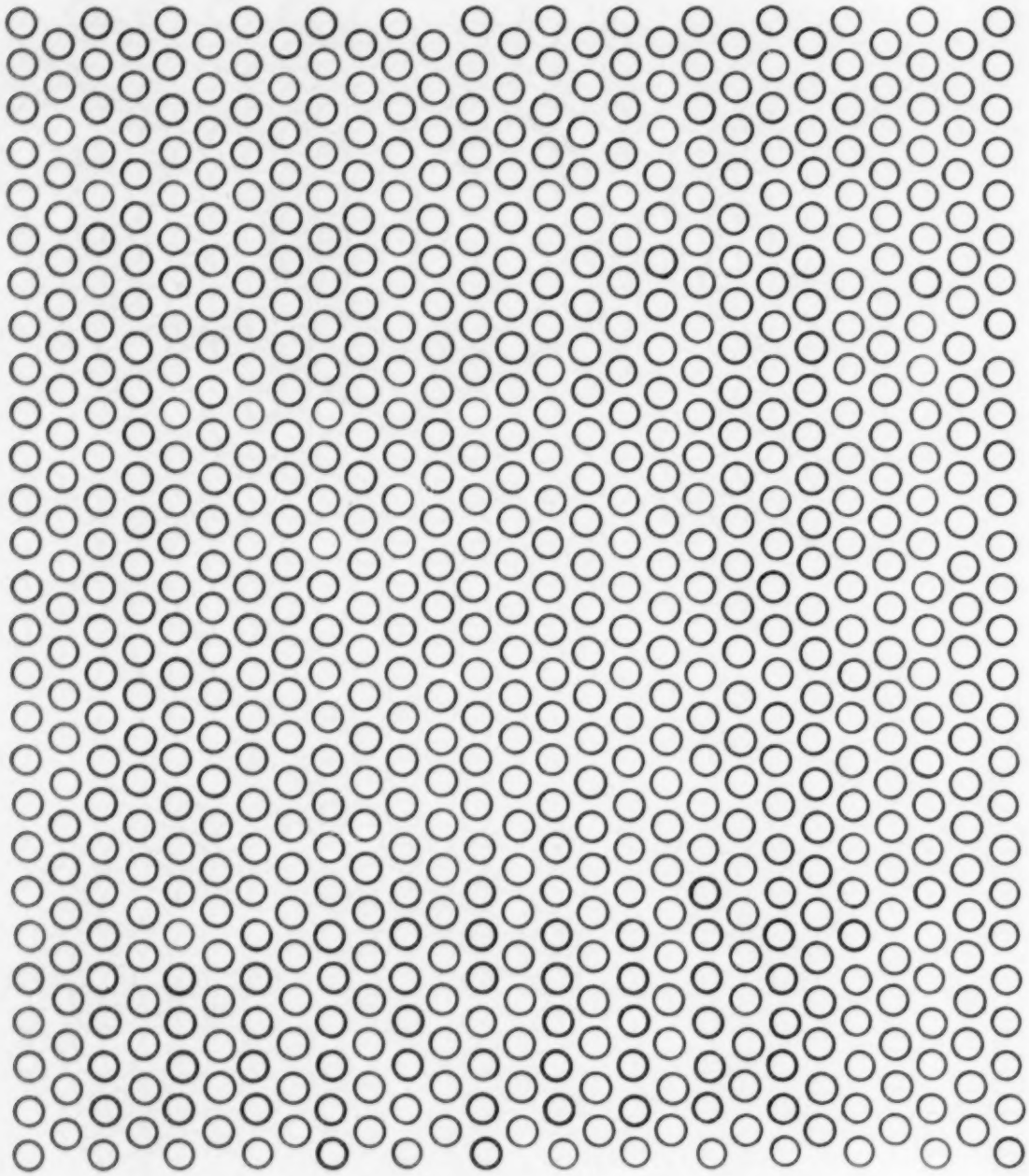

DIRECTION OF LIQUID FLOW
SCALES FOR 3 IN. CAPS, USE 1 IN. = 15 IN.
0 10 20 30
FOR 4 IN. CAPS, USE 1 IN. = 20 IN.
0 10 20 30 40
FOR 6 IN. CAPS, USE 1 IN. = 30 IN.
0 10 20 30 40 50 60

Fig. 36—**BUBBLE-CAP LAYOUT CHART—CAP SPACING 37.5% CAP DIAMETER**

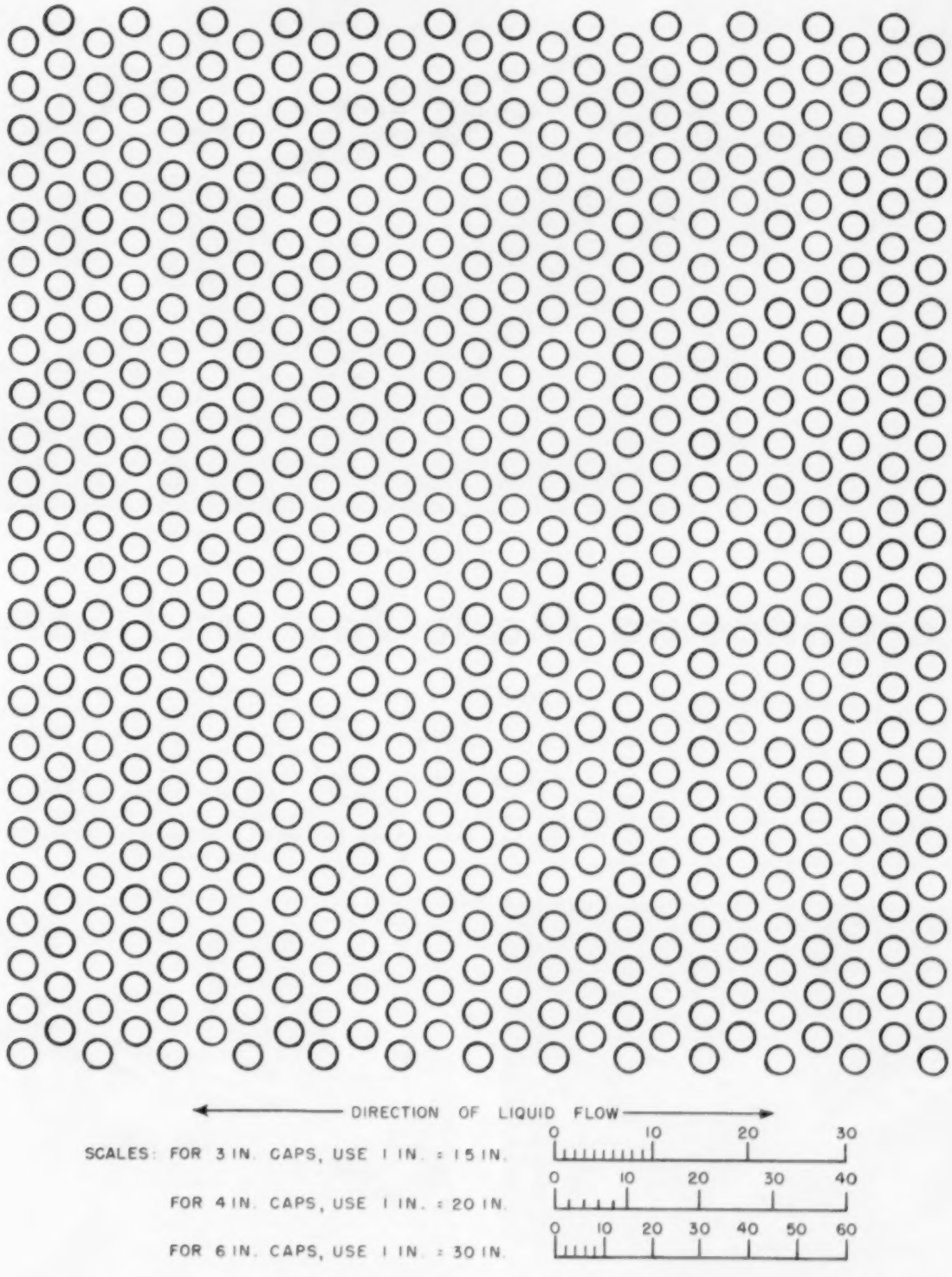

DIRECTION OF LIQUID FLOW
SCALES: FOR 3 IN. CAPS, USE 1 IN. = 15 IN.
0 10 20 30
FOR 4 IN. CAPS, USE 1 IN. = 20 IN.
0 10 20 30 40
FOR 6 IN. CAPS, USE 1 IN. = 30 IN.
0 10 20 30 40 50 60

Fig. 37—**BUBBLE-CAP LAYOUT CHART—CAP SPACING 50% CAP DIAMETER**

FINISHING A FIREWALL with two of Sun's new Gradalls. On jobs like this one operator and a helper can eliminate as many as 18 hand diggers

Earthmoving Made Fast and Easy

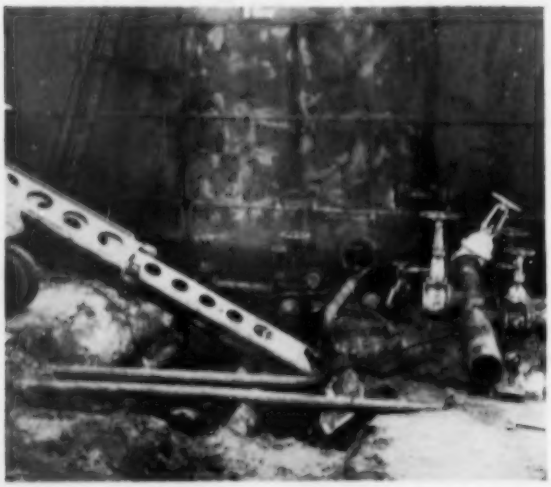
AT SUN OIL's Marcus Hook, Pa., refinery, a "fleet" of three "Gradalls"—hydraulically controlled precision diggers—is solving several troublesome earthmoving problems.

Because the units need little working room and because their working heads can be placed exactly where the earthmoving is wanted, they are proving almost ideal for such jobs as:

- Probing for and clearing underground pipe in maintenance operations.
- Lifting out old pipe and placing new sections during relocating work.
- Fire wall finishing.
- Ditch digging, backfilling, and packing.

The flexible units can also be used for tank cleaning. They remove plates and clean out sludge. A variety of bucket sizes permits all types of jobs to be handled.

A number of refining companies besides Sun are now using this equipment, according to the manufacturer, Warner & Swasey Co.



A TICKLISH JOB, clearing earth from a jumble of pipe and valves

LOCATING BURIED PIPE among existing and exposed piping systems

How "Bad" a Diesel Fuel Can the Railroads Use?

- *The railroads can use a lower grade of fuel in their diesels. Particularly in the new mechanically improved locomotives.*
- *Trial and experiment can be used to determine just how much present fuel specifications can be lowered without affecting equipment performance or running up excessive maintenance costs.*
- *Distillate supply-demand conditions in the next 10 years will force the roads to widen their usable fuel range as much as possible.*

THESE HIGHLIGHTS summarize findings of a 10-year study of railroad diesel fuel quality recently completed by the Diesel Fuels Division of the Coordinating Research Council, Inc. The CRC is a cooperative research agency sponsored jointly by the American Petroleum Institute and the Society of Automotive Engineers. The study was reported at the SAE annual meeting in Detroit in January.

Twenty-two oil companies, railroads and Diesel locomotive builders participated in the test program inaugurated in 1945 by CRC, at the request of the Western Petroleum Refiners Assn. Extensive field service tests were made. There were eight one-year projects with three types of locomotives. Two types of fuel were tested: normal railroad diesel fuels and fuels which allowed wider latitude of sulfur content, cetane number and final distillation point.

"It appears," the report concludes, "that fuels of the type tested can be used without affecting locomotive availability, if proper precautions are taken."

The research program did not clearly demonstrate that a wider range of fuels can give universal performance equal to that of the present fuels of narrow specifications. The report brought out that the field tests caused increases in engine deposits, wear, and contamination of filters and lubricating oil. In five of the tests the fuels did not interfere with locomotive availability. However, in three tests, changes in materials or maintenance methods were necessary for continuance of operations.

The greatest value of the test was that it focussed the attention of railroad executives on the economic benefits to be realized by relaxation of their present strict fuel requirements. These benefits will be in savings in the cost of diesel fuels at the refinery and in the transportation cost of the fuels. Today, many railroads must shop widely to find available fuels meeting their close standards, instead of buying at refineries near the point of use.

The size of the railroad diesel fuel supply problem has grown until, now that U.S. railroads are 85% dieselized, its importance cannot be overlooked. The roads today operate 25,325 diesel locomotives, totaling 35.4 million horsepower, plus many smaller diesels in work equipment. In 1953 the roads used 75,246,000 bbls. of diesel fuel—second in volume to heating oil among distillate fuel uses.

Two types of diesel fuel were used in the CRC field service tests, both within the ASTM No. 2 distillate fuel classification, and specifically within the ASTM D975 classification for No. 2D fuel.

In each instance the test fuel approximated a "target" fuel, with 1.0% sulfur content, 40 cetane number and 700°F. final boiling point. This was higher in sulfur and final boiling point and lower in cetane number than the present railroad fuel requirements. The target fuel was selected because it was believed to represent characteristics of diesel fuels that could be supplied in largest volume over the next 10 years. The control fuel was that one normally used by the railroad. The accompanying table shows the variation in the significant characteristics in the fuels tested.

Only the three qualities of sulfur, cetane number and end point were considered in the tests, to simplify the test program. It was pointed out by the study group that other fuel properties may adversely affect locomotive operation. Instability in storage and high cloud and pour points are examples of such properties encountered in the tests.

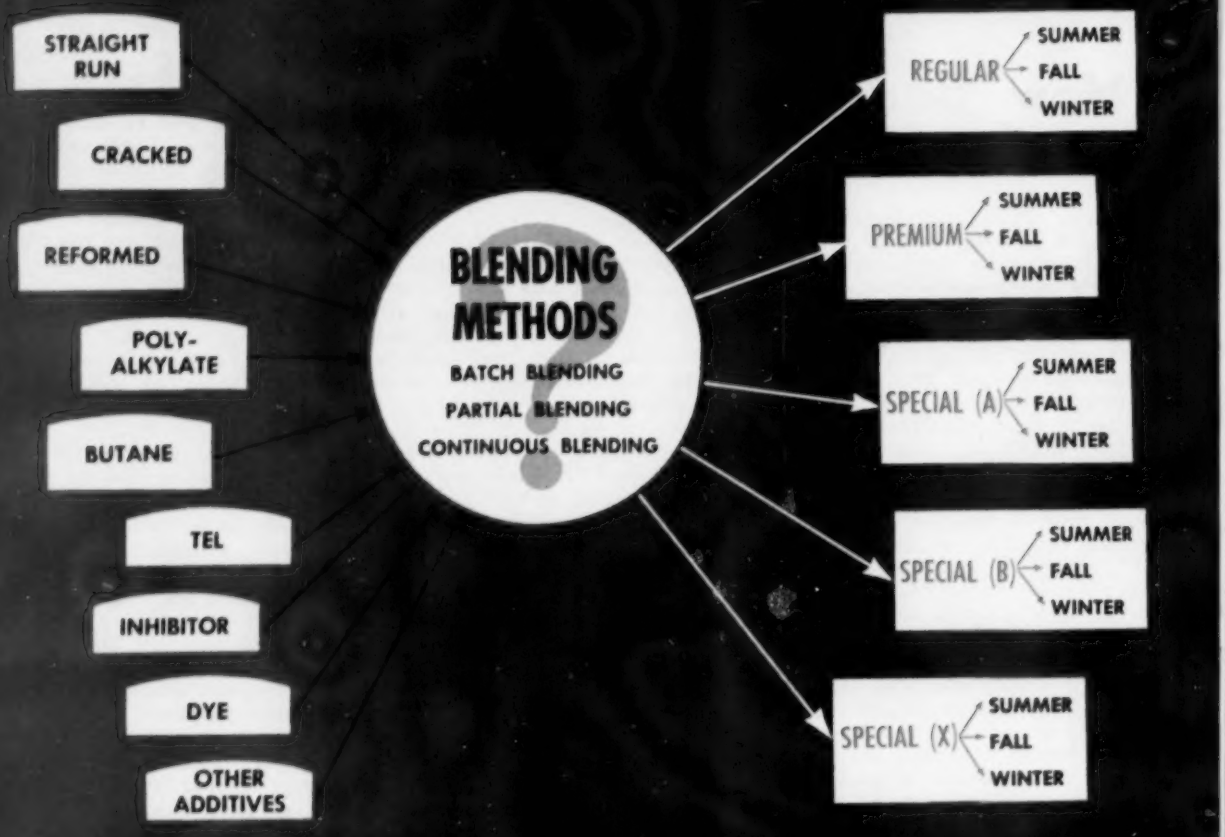
The first field test in the CRC program was started in 1949 and the last one completed in June, 1955. The eight tests involved a total of 34 diesel engines of three makes and were equivalent to approximately 38 engine test years. The test program covered 2.5 million unit-miles of combined high speed passenger and average-duty to heavy-duty freight operations and 8000 hours of switching service.

Uniform procedures for testing and reporting were formulated by the group on Full-Scale Field Service Tests of Railroad Diesel Fuels. Each test was made by a team composed of a technical man from the railroad, the oil company supplying the fuel and the engine builder. This team made periodic joint inspections of the engines during tests and members rode engines at regular intervals to evaluate service performance. An Analysis Panel then reviewed all the test data, and compiled the final report which was presented at the SAE meeting in Detroit.

Significant Variables in the Properties of Railroad Diesel Fuel Oils Used in the CFR Field Service Tests

Test No.	Fuels	Sulfur Content %	Cetane Number	End Point F.
1	Test	1.00	42	695
	Control*	0.155	47	632
2	Test	0.95	48	686
	Control	0.45	49	640
3	Test	0.98	45	625
	Control	0.31	53	616
4	Test	1.15	43	649
	Control	0.30	51	635
5	Test	0.90	39	644
	Control	0.51	45	611
6	Test	1.00	42	647
	Control	0.42	49	642
7	Test	1.10	44	687
	Control	0.21	54	634
8	Test	1.00	42	697
	Control	0.29	49	636
	Test Fuel Target	1.00	40	700

*Control is the fuel normally used by each railroad.



Today's Growing Problem...

Which Blending Method Is Best?

By B. G. CRANE, Manager of Operations,
Petroleum Chemicals Division, Organic Chemicals Department
E. I. du Pont de Nemours & Co.

PRESENT day refiners face an increasingly complex problem—the final blending of finished gasoline. Constant demand for higher octane motor fuel, research for more efficient methods to produce it, and the design and installation of new equipment to handle a variety of crudes—all have caused an increase in the number of components and additives in finished gasoline, and have greatly complicated final blending operations. (See chart above.)

The key to economical operation may well be efficient blending techniques, resulting in conservation of product, especially the more expensive high-octane-number components.

Already, great strides have been made in the operation of process units. Automation, which we read so much about today, is commonplace in petroleum processing. In fact, the petroleum industry has been the leader in this field, being the first of all process industries to use it.

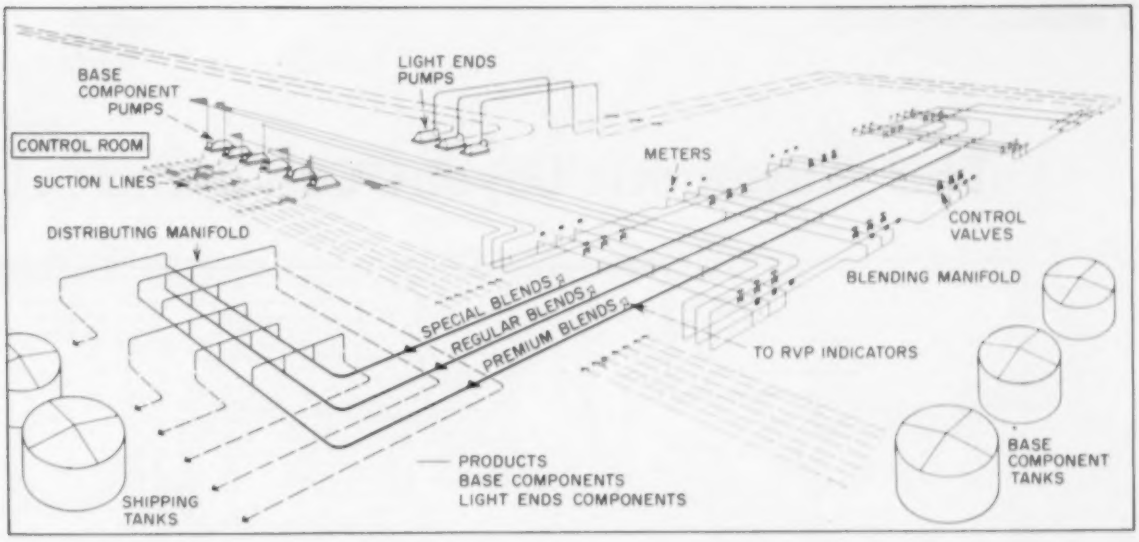
We hear also about the automatic tank farm, the use of digital computers, scanning devices, automatic sensing and feed-back systems, memory devices, and controllers that respond automatically, accurately and instantly to adjust process conditions to the optimum or set point. All these have resulted in more uniform product quality, maximum yields, and more economical operation.

Until recently, however, these methods of automatic control have not been applied to blending and dispatching operations.

Yesterday, it was a simple matter to blend a little casinghead or cracked gasoline with the straight run from the stills. But, as the demand for gasoline outran the production facilities (which then produced only 25% gasoline from the crude) new processes were developed to squeeze more and more gasoline out of each barrel of crude. And the trend continues.

Today every refiner faces the problem of blending from 4 to 10 components into his gasoline, from an even greater number of production sources—plus an increasing array of dyes, inhibitors and other additives. Within the next 20 years gasoline demand is expected to increase by 62%.

To meet this large demand refiners



PARTIAL ONSTREAM BLENDING—one of three techniques refiners use today for producing finished gasoline and other products

must develop many ways for getting more gasoline from every barrel of crude, and do it in less total space—or else find entirely new sites for expansion. Efficient gasoline blending techniques that will conserve space and blending time, increase tank utilization, and give increased operating flexibility will play a large part in meeting the future demands.

Three general methods are available today to the refiner for blending the products from his process units: (1) batch blending, (2) partial on-stream blending, and (3) continuous on-stream blending. The type used often depends on local refinery conditions. But, as almost every company faces major revamping or expansion to accommodate increased throughput, or the creation of completely new facilities, the choice of the best physical facilities and operating procedures for blending unfinished gasoline must be made.

Advantages of Continuous On-Stream Blending

Most continuous on-stream blending is found in new refineries, although some older ones have justified its installation when expanding or revamping. Those who have selected automatic continuous on-stream blending within the last three to five years claim many benefits, although each refiner may have had different reasons for initially adopting it. Their justifications, in all cases, have been found among the following reasons:

1—Increased tank utilization.
2—Elimination of reblending.
3—Elimination of quality giveaway.
4—Reduced loss of light ends.
5—Blending closer to ultimate specifications.
6—Flexibility of maintaining inventory in base stocks.
7—Lower power costs.
8—Reduced inventory of TEL and other additives in finished gasoline.
9—Simplification of butane shrinkage factor.
10—Increased safety.

What Are the Problems?

It is recognized, generally, that there may be some situations which cannot justify automatic continuous blending due to: (1) physical conditions at the particular location involved, such as inadequate throughput to justify initial investment, or (2) existing standards or practices within the industry, such as certification of quality and quantity for custody transfer.

Some specific conditions existing within a refinery that may present a problem in the transition to continuous blending are:

- Only a small number of finished grades of gasoline are produced.
- Rearrangement of lines, due to awkward location of present tankage, would be too costly.
- Existing throughput capacity of less than 20,000 to 25,000 b/d. may not justify automatic blending, with the possible exception of completely new refineries.

(Text continues on page 86)

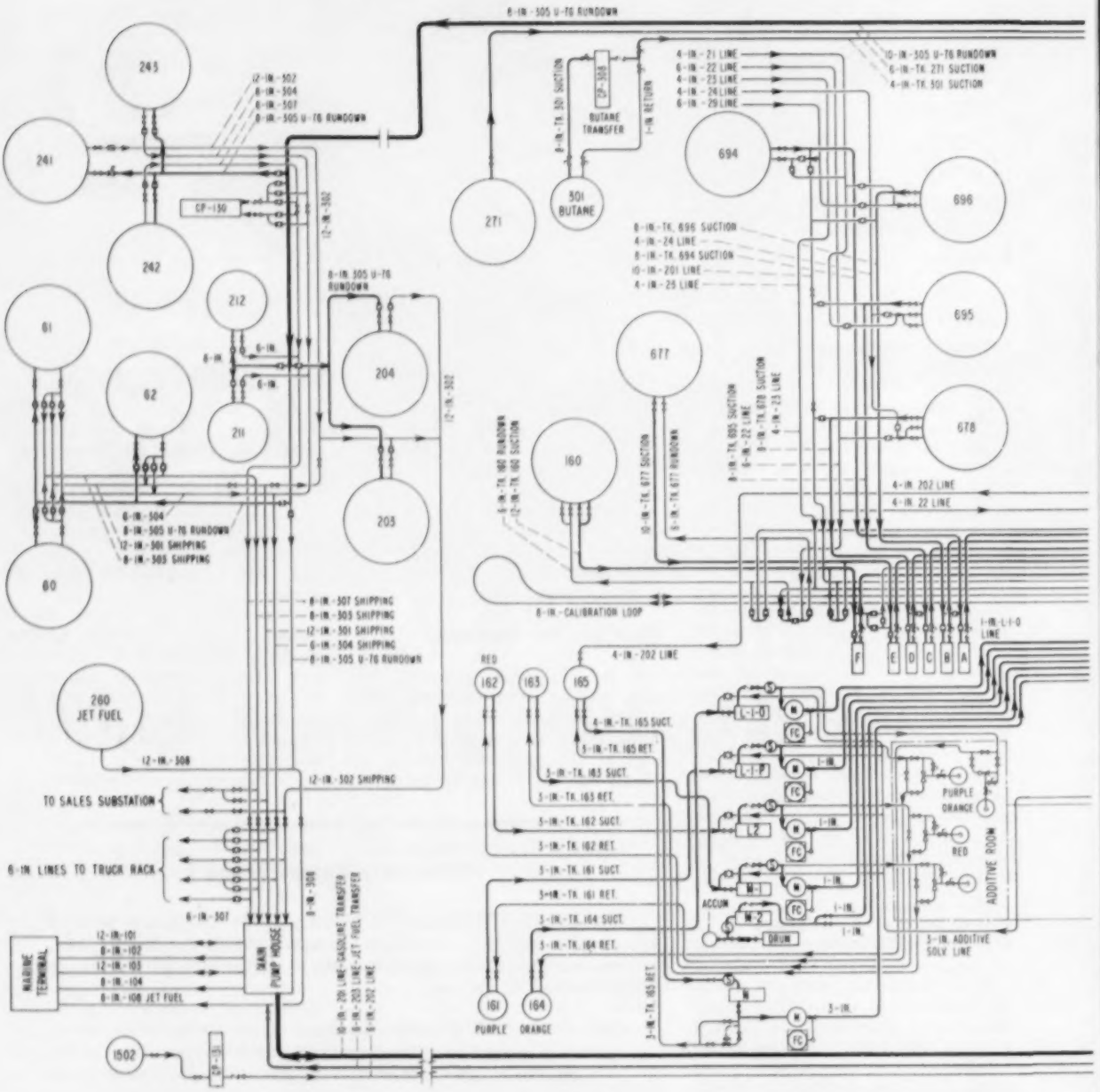
What the Terms Mean

BATCH BLENDING—The addition of the component parts of gasoline, one by one or in partial combination, in a mixing tank, so that the specified product is not available without completing the mixing in the tank.

PARTIAL BLENDING—Addition of all components simultaneously in the line at the desired ratio, but stopping short of the total quantity required, then final adjustments and additions made as indicated by last-minute tests, followed by final agitation in a mixing tank.

CONTINUOUS AUTOMATIC BLENDING—Addition of all components of the gasoline simultaneously in the line, along with the lead and dye, so that at any given moment finished specification gasoline is available directly from the line.

This Automatic Layout Can Blend . . .

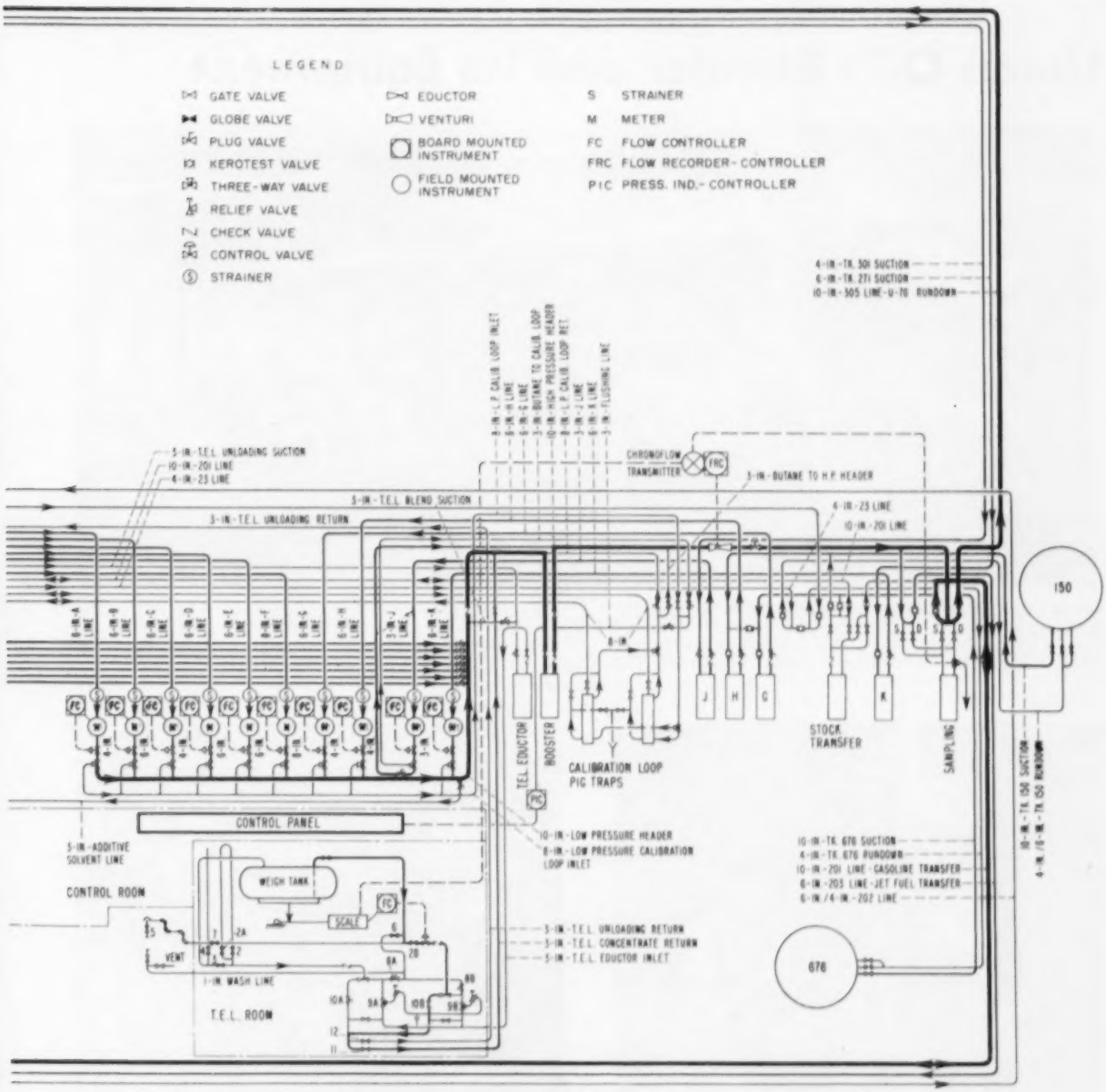


WHAT AUTOMATIC, CONTINUOUS, IN-LINE BLENDING of gasoline means is shown in this plot plan of the new installation at Union Oil Co. of California, at Oleum. This flow diagram shows the pumps, meters, lines, and component stock tanks in their approximate physical location, except for the group of tanks and the main pumphouse on the left. This latter segment of the layout was moved closer to the balance of the installation in this drawing to permit its reproduction on these two pages.

This unit will produce up to 5000 bbl/hr of finished

THIS MONTH'S COVER picture is an exterior close-up of the blending system installation at the Oleum refinery of Union Oil Co. of California.

120,000 b/d of Ready-to-Ship Gasoline



gasoline. Product is pumped to shipping tankage, shown at the left side of the diagram, or directly to tankers at Union Oil's marine terminal.

Flow controllers shown schematically adjacent to their respective displacement meters are actually contained in the main control panel. A solid jointed shaft runs from the meter counter through the control room wall to the differential gear actuating the flow controllers.

Manifolding is provided so that individual components can be diverted from the low pressure blend header to the 500-ft. meter calibration loop, passing through this loop and returning to the low pressure blend header. In this manner, no component is lost during meter calibration.

For Pictures of Equipment, turn page . . .

■ Which Blending Method?

• Product quality or production rates of processing units is not sufficiently constant.

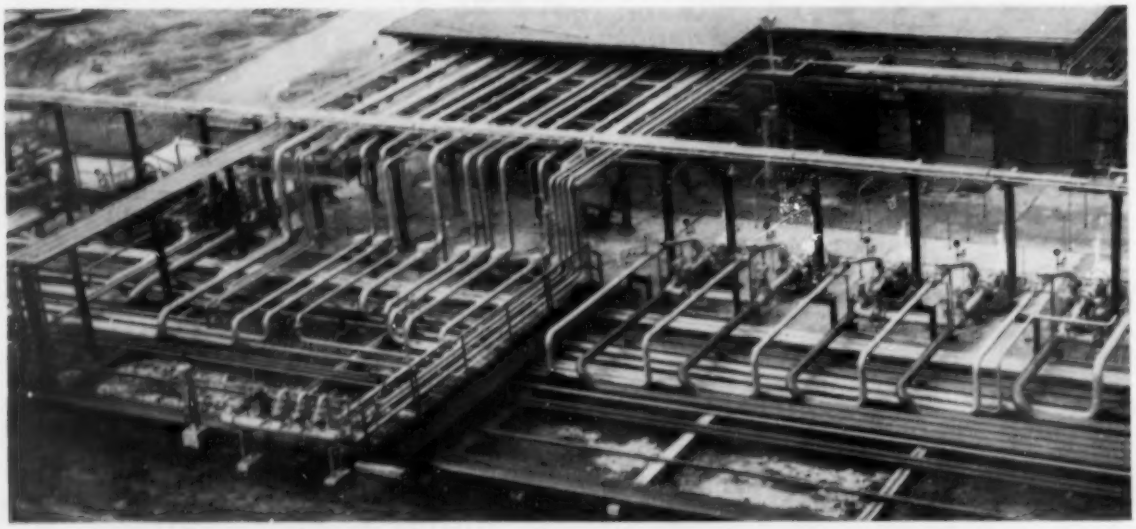
Two industry conditions which, in some cases, must be overcome in order to obtain full advantage of continuous blending are:

• Certification methods, as now approved, are based on manual gauging and laboratory analysis of final product before loading. New procedures for determining quality and quantity for purposes of certification must be adopted by the industry.

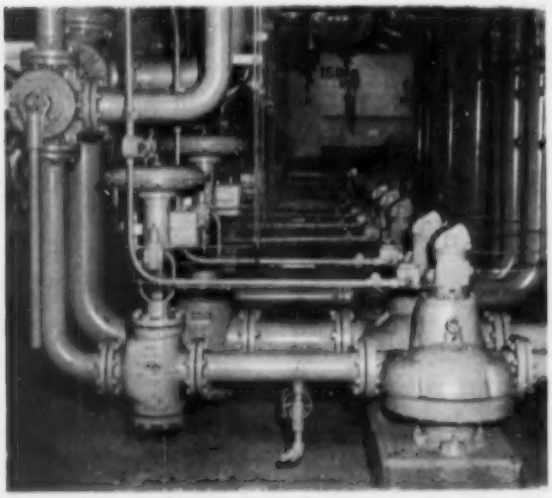
• Certification contracts with recognized agents, i.e., Martin and Saybolt, for instance, may require rewriting.

As the use of continuous blending increases, demand within the industry will force a solution to these objections. Fortunately progress along these lines has been characteristic of the oil industry. Individuals, and the industry as a whole, have been charac-

Union Oil's Blender and Its Equipment



MAIN CONTROL HOUSE AND MANIFOLDING of the continuous, automatic, in-line gasoline blender at Union Oil Co. of California, Oleum. The component pumps and booster pump are in a line across the foreground. The discharge piping leads to the meter bay. The calibration loop pig traps are at the far left. Additive pumps and meters are to the right of the control house which appears in the right background in the photo



LINE-UP OF MAIN METERS: Components flow through each meter, then a controlling motor valve and into the low pressure blend header by a three-way cock whose third port opens into the calibration loop. Counter topworks on each meter is used for calibration, being electrically engaged and disengaged when the calibration loop pig trips contacts at each end of the loop

MAIN CONTROL PANEL, showing the master flow controls (in the panel in the foreground) and the ten component panels for each of the various hydrocarbon stocks used in the center section. The panels for five different dyes and additives are at the far end of the master panel. Bechtel Corp. was design engineer for the overall system. Proportioneers, Inc. designed and supplied the equipment

terized by an alertness to improved techniques in order to improve quality, reduce cost, and maintain a favorable position in this highly competitive field.

The final step of blending gasoline may seem relatively unimportant, even to those involved in the production of its various components. Only when the great number of variables and operations involved in this seemingly simple operation are considered, is it appreciated what opoprtunities there are for cost reduction through a more efficient system like continuous blending.

Some of the many variables involved in mixing the complex cocktail known as gasoline are:

The Variables . . .	and the Possible Variations
Base Stocks	Up to 10 possible
Dye	Up to 4, dependent on number of grades produced
TEL	Two grades (aviation and motor mix)
Inhibitor, and other additives	Five are possible
Component Production Rates	Dependent on process unit capacities
Blending Rate	Depends on size of blending equipment and availability of tankage
Type of Product Delivery	May be by tanker, pipe line, tank car or tank truck

To produce motor fuel, today's refinery effectively combines all these variables by one of three methods: batch, partial on-stream, or continuous on-stream blending.

What Are the Alternatives?

Batch Blending

Common practice in batch blending is to transfer measured (manual-gaged) quantities of base stocks, one by one, into a mixing tank; agitate; and test for volatility and lead requirements in the laboratory. Based on these analyses, butane and tetraethyl lead, dye and other additives are added. Following the addition of these, some form of agitation is required to assure uniformity in the tank from top to bottom. The lab then makes a final check from blend samples. If specifications have not been met, the blend is spiked to meet them, and then re-sampled and analysed.

In-tank batch-blending operations involve considerable manpower from the refinery dispatching department, which first sets up the schedule of pumpovers from component rundown tanks to the blend tank. The gagers and pumpers then line up the valves, handle the pumps, and gage successive quantities. Following lab analysis, the lead-plant operators add tetraethyl lead (along with other additives), recirculate for final blending, and collect samples for final analysis by the lab.

Partial On-Stream Blending

Partial blending eliminates two of the obvious disadvantages of batch blending: (1) consecutive pumping, and (2) the tieup of component tanks. All base stocks are pumped simultaneously, and preblended in the line before they enter the mix tank. The total time of pumping is reduced to the time required to pump the greatest component—and this can be minimized by supplying a larger pump and line for that particular base stock.

Almost any existing batch blending system can be converted to a partial on-stream blending system by the addition of a few pieces of equipment (like pumps), or the adoption of a few simple operating procedures. Two of these are:

1—Installation of separate pumps for each component.

2—Installation of instruments for controlling rates of flow, plus continuous recorders.

These last aids will give the operator up-to-the-minute guidance for pumpovers, allowing him to keep components in proper proportion at all times.

This system can reduce the time of multiple pumpovers, save component tankage and reduce the overall mixing time.

One example of partial on-stream blending, which closely approaches continuous on-stream blending, is that carried out by a large refiner. As shown in the drawing, each of the nine gasoline components is delivered to a blending manifold by individual motor-driven pumps. The pumps discharge the selected components through individual meters and control valves, which proportion the stock according to preset values to three collecting lines. The outlet of each of these lines is manifolded to various field lines which transfer the partial blend to shipping tanks. In each case, a run is stopped 10,000 bbl. short of the finished blend.

Since it is this refiner's policy to inspect and approve all shipments by lab analysis at least 24 hrs. before the blend is shipped, gasoline is not blended directly into boats and pipelines. Instead the last 10,000 bbls. of a blend are added in the shipping tank with the addition of TEL, dyes and other additives—plus any last minute spiking for closer volatility approach. During this final blending, the shipping tank contents are circulated by pumps or in-tank mixers. Final inspection of the gasoline is made from the blend-shipping tank before it is released for loading.

Gasoline components are stored separately, but dual tankage is not provided because of space limitations. This means that production is continually running down to the same tanks used for blending. Due to the complexity of operations, the quality of each component changes from hour to hour, and it is necessary to adjust the blending for these hourly variations.

Some of the devices used to compensate for component variations are: a panel board in the pumphouse that contains indicating flow controllers and recorders; an instrument that continuously records RVP; and another that records the % off at 158°F.

The use of these aids gives the pumpers up-to-the-minute guidance—as compared to several hours' time delay with the usual laboratory sampling methods—and allows them to adjust the percentage of components so that the blend in the line will be as close as possible to ultimate specifications at all times.

This type of system has the advantages of lower pumping costs, since pumps and lines can be sized to component percentages; a shorter blending time, since most of the initial blending is done in the common pipeline; and closer blending to ultimate specifications.

However, complete on-stream blending is not achieved as it is still necessary to pump over the final 10,000 barrels and spike for closer volatility approach. Adding the TEL, dye and other additives with the final 10,000 barrels requires another period of mixing before final analysis can be made prior to shipment.

Continuous On-Stream Blending

The accompanying illustrations show the type of equipment that allows the addition of all blending agents or components of motor gasoline simultaneously with lead, dye, and other additives, such that at any given moment finished specification gasoline is available in the blend manifold.

Continuous on-stream blending allows the refiner to make up any blend, and pump it directly to a waiting tanker, pipeline, or tank. Those using this method report that quality and quantity are within specified limits at all times.

■ Which Blending Method?

A typical procedure is similar to this:

Step 1—From available laboratory data on components, a mathematical blend is computed. A lab blend is made and analyzed.

Step 2—Based on this lab analysis, the operator of the blending plant is given a formulation from which he sets up the desired readings on the blender control panel.

Step 3—The blender is started and, if desired, each component pump can circulate on itself until all flows check.

Step 4—The blender is placed "on-stream" and the correctly blended gasoline goes directly to the waiting tanker, pipeline or terminal storage.

Quality control depends upon accurate analysis of individual components before the blending begins. For best results this requires dual run-down tanks, or constant quality control on the rundown from the process units. The final blend, of course, can be checked during the blending as many times as is desired. Constant results can be expected, for during the operation of Shell Oil Co.'s Wood River, Ill., blender for pipeline shipment, not one off-specification tender has been delivered in over two full years.

Two types of control are used in automatic blending: (1) individual flow control, or (2) integrated flow control. For individual component flow control the automatic control valve in each component line regulates at the set rate *only*. This is adequate for loading or transferring at constant rates. But, if the total flow requirements change, then it is necessary to reset each of the flow controllers to meet the new demand.

With an integrated flow control system such as that at Shell's Wood River Products Pipeline Pump Station, changes in total rate are accomplished without upsetting the relative proportion of the components. When pumping requirements change—such as rate variations resulting from the differences in resistance to flow of the various products moved successively through a products pipeline system and take-off operations to intermediate terminal points—all component flows are altered immediately, in the same proportion. When the integrated system is used for tanker loading, component flows are similarly proportioned on topping-off operations by throttling action of the discharge valve controlling the entire stream. At all times, the blend is accurately controlled, with the same percentage relationship for all components, even though total flow fluctuates.

In both types of continuous on-stream blending, flow of components and blended product can be checked through metering—using positive-displacement, venturi, or area-type meters. However, since no measuring device is any more accurate than the methods available for calibration, the calibration of meters becomes an important part of a continuous on-stream blender. Two methods are possible.

The first method uses an accurately-calibrated, auxiliary meter in a by-pass loop around the individual component meter. This auxiliary meter is calibrated by a separate calibration tank. Flow is directed through a component meter and the auxiliary meter in series, thus allowing an accuracy check without going off-stream.

Another method favored is a calibration loop, built as an integral part of the blending unit, so that flow meters can be calibrated during actual operation, without being taken off-stream and affecting the total gasoline in the blend. In the newer installations, like Union Oil's at Oleum, Calif., where pumping rates are 3,500 gpm, this method permits calibrating any one of the ten parallel stock meters at any time by diverting the component through the loop and back to the main stream.

A calibration loop is nothing more than a positive-displacement piston measurement, using a tight-fitting plug, made of several flexible disks on a steel shaft, moving through an accurately measured volume of the pipe loop.

The Case for Continuous On-Stream Blending

In deciding which type of blending will be best for a given condition, the prime problem is justification of the necessary expenditures. Those who have already adopted continuous on-stream blending have found such justification from the list of 10 advantages cited previously.

1—Increased Tank Utilization

Tankage is the most costly single item of equipment of any blending facility. When costs such as real estate, piping, etc. are considered as functions of tankage, with the tank alone in some cases costing up to $2/barrel, any method of reducing tankage appears attractive.

Continuous blending offers the opportunity to store gasoline as component base stocks, eliminate blend tanks, and reduce finished storage tankage. It does not mean trading finished storage tankage for component storage tankage, because with true continuous on-stream blending, any required gasoline can be blended from component tankage and pumped directly to its carrier, whether pipeline or tanker. This can mean a real saving in unproductive storage of the finished product (and hastening it on to the customer), as well as the elimination of blending tankage.

At Union Oil's new blending facilities at Oleum, Calif., it is possible to blend in 12 hrs., to refinery shipping tankage or directly to tank ships, a quantity of gasoline formerly requiring 4 to 5 days to produce by batch blending.

One other large refinery with a gasoline production figure of 80,000 b/d has a total storage capacity of 2.8 million barrels. This tankage is split as follows:

	Est. Replacement Value
1.1 million bbls, finished storage	$2,200,000
0.20 million bbls, high RVP blending stock	400,000
0.25 million bbls, unfinished component	500,000
1.25 million bbls, blending and shipping	2,500,000

Normal blending in 80,000-bbl batches requires a period of 30 hrs. at this refinery. During the past year, it has been using nine blend components to meet requirements for 25 specification blends, including seasonal changes. At a production rate of 80,000 b/d., this means a *theoretical* minimum of two 80,000-bbl. tanks used alternately for blending alone. To transfer the blends to separate storage tanks at a rate of 5,000 gpm ties up blend tanks for another 11-12 hrs.

Thus, continuous on-stream blending can eliminate a minimum capital investment of $320,000 in blend tankage alone. Alternately, the same tankage will handle more throughput. Continuous blending also offers a real opportunity to reduce the $2,200,000 invested in finished storage tankage.

2—Elimination of Reblending

The necessity for reblending may result from several causes: non-uniform components; operational difficulties, such as a shortage of components; or sudden demands for special grade fuels which might not be available. One or more of the following characteristics may prevent a blend from meeting shipping specifications and require reblending: octane number, RVP, distillation, or sulfur content.

If the product from units is not

constant, it is usually necessary to pair the tankage for each component, with one receiving rundown and the other tank analyzed and available for blending. If the rundown product is uniform, the rundown tank may be used as base stock for blending—a desirable setup for conserving tankage.

But, whether the gasoline components are withdrawn from rundown tanks or separate base stock tanks, continuous blending allows direct mixing to specifications. All components can be combined according to a previously laboratory-determined and analyzed formula, and the blended product piped directly to tanker, pipe line or final storage. There can be full assurance that the blend is "on-specs" with no need for reblending. "Hold-and-release" tankage can be reduced, as well as extra transfers of large blends from blend tank to release tank.

In effect, continuous on-stream blending expedites dispatching operations and eliminates transfer power costs and evaporation losses. The tanks, lines, and pumps normally used for these operations can be released for other uses.

3—Elimination of Quality Giveaway

When tankage for reblending an "off-spec" blend is not available, then it is often necessary to resort to quality giveaway—which means handing the customer a higher quality gasoline than he ordered, or is going to pay for. One very large refiner, with inadequate tankage to permit reblending, was amazed to discover that his quality giveaway approximated $1-million annually.

Items other than lack of reblending capacity may compel quality giveaway. Peak shipping requirements due to delayed tankers, shortage of blending components, or shipping commitments may compel the loading of a gasoline of higher quality than contracted for.

4—Reduced Loss of Light Ends

When butane is mixed in a blend tank with other components, the short distance that the butane bubbles travel before reaching the surface of the blend prevents complete absorption. As a result, expensive butane is bound to escape through the tank vent system. And in spite of recent developments in vapor recovery systems, tank agitation by recirculation or mixers, along with multiple transfer operations involved in batch blending, will result in the loss of some light ends.

Stream blending minimizes these losses through complete absorption of butane in the lines, and elimination of mechanical mixing and multiple pumpover operations.

5—Blending Closer to Ultimate Specifications

When combining components (which in themselves are expensive products), accurate blending is one way to control closely the final product cost. Continuous on-stream blending allows more accuracy by controlling at all times the quantity of each component and, therefore, the quality of the final product.

When coupled with continuous sensing devices, such as a Reid vapor pressure recorder, it is possible to alter blends at any time to compensate for changes in rundown quality, without going off-stream. When using continuous flow recorders, the operator can be guided in making instant volume adjustments to meet varying conditions of pressure. If memory totalizers are part of the blending system (as at Union Oil's Oleum installation, and Shell's Wood River installation) it is also possible to compensate during blending for any flow failures resulting from temporary loss of a component.

Individual flow control requires that the operator watch the flow recorders and reset the flow controllers as the pressure head or suction varies. Using integrated flow control, these adjustments are made automatically.

At present, blending is based almost entirely on quantity measurements (volume) of laboratory-analyzed components. If and when additional sensing devices are perfected, and motor fuel blending can be based on continual *quality* analysis of the final blend, then the desired finished properties of the blend will reach the ultimate in accuracy, and cost of production will be even further reduced.

6—Flexibility by Maintaining Inventory in Base Stocks

Continuous blending allows motor fuels to be blended shortly before final transfer, thus reducing the tankage normally required for storing large inventories of finished blends. This flexibility of maintaining inventories in base stocks means that unexpected demands for special blends can be met, with less chance of delaying shipment and incurring possible tanker demurrage at $120-240/hr. Some refiners must meet demands for as high as 36 different blends during the year, from as many as 12 components running down from as many as 30 production sources.

Inventory in component storage rather than finished product means that tanks can be kept filled closer to maximum top working levels, since there is no need to tie up many partially-filled tanks with special grades of fuel. Thus one of the most valuable refinery tools, flexibility, is gained through maintaining inventory in component tankage, giving increased tank utilization as well.

7—Lower Power Costs

By eliminating the necessity for multiple pumpovers and the agitation required for mixing, power costs can be reduced through continuous on-

Meet the Author

B. G. Crane

For the past ten years, B. Gardner Crane has been manager of operations of the Petroleum Chemicals Division of E. I. du Pont de Nemours & Co., Inc. He has been actively engaged in problems relating to the blending of TEL and other additives with gasoline for the past 23 years.

During this entire time Mr. Crane has assisted in the design of facilities for blending TEL and other gasoline additives and has worked closely with refining companies throughout the United States, Canada and abroad. He has worked closely with engineering firms, engineering departments of oil refining companies, and equipment vendors. He has had to consider all blending methods, ranging from ordinary batch operation to the continuous onstream blending of gasoline components and the flow-proportional addition of additives.

As a result of his many contacts with the industry, he has seen the evolution of continuous onstream blending and, through the years, has perhaps gathered more information on methods being used than anyone else in the United States. In this article he reports in a general way on the various methods of blending, some of the problems involved, and the results reported to him by users of all methods.

stream blending. Since blending rate need only match production rates (though most refiners prefer to blend total production in one 8-hour shift), sizes of pumps and lines can be reduced. This will result in additional power savings and will lower the initial expenditure for equipment.

8—Reduced Inventory of TEL and Other Additives in Finished Gasoline

The value of tetraethyl lead and other additives which are tied up in finished inventory frequently represents a sizeable investment. For example, in the previously mentioned case of a refinery with finished storage capacity of 1.1 million barrels: at 80% tank utilization, and an average dosage of 1½ cc/gal of TEL—the investment in TEL alone in finished storage is over $100,000.

Although continuous blending does not reduce the use of TEL and other additives—nor the total inventory of hydrocarbons, it does allow appreciable reduction of the additive investment tied up in finished storage. Anyone concerned with successful inventory control will appreciate this opportunity of minimizing inventory investment.

9—Simplification of Butane Shrinkage Factor

Butane shrinkage is a physical phenomenon that must be recognized for accounting purposes. When butane and other hydrocarbons are mixed, the total volume does not always equal the sum of the two added volumes. This is due to molecular mixing of butane with other hydrocarbons—similar to the mixing of alcohol and water. By the addition of butane, there is a loss in total volume, which complicates any accounting system. Stream blending simplifies this accounting procedure since accurate metering of butane eliminates the question of which gauging operation was accurate. And, it may save adding unnecessary butane to the blend.

10—Greater Safety

The two most significant hazards in the blending of finished gasoline are the additions of butane and tetraethyl lead.

Until recent years, a common method of adding butane was to wait until all components of the mix were in the tank, and then blow with butane. The resulting agitation of the tank contents was sufficient to complete the mixing. But, the resulting fires, and loss of butane to the venting system, have caused this method to be largely discontinued in favor of in-line addition.

With batch blending, even though in-line addition of butane is practiced, its concentration during the addition is usually several times the desired finished concentration. This results in the inevitable loss of some butane to the venting system, with residual fire and explosion hazards.

For batch blending of TEL, the usual practice is to "slug" it in at rates up to 250 lbs/min. This causes the TEL return line to contain gasoline under pressure with a lead concentration of 100 cc/gal or more, depending on the capacity of the pump. Under such conditions, a line break or leak represents a serious potential exposure of personnel, plus the loss of TEL and product. A costly and hazardous decontamination job is also required.

Continuous on-stream blending, with automatic flow-proportional addition of butane and TEL, allows these expensive ingredients to enter the line at the desired finished concentrations. This practically eliminates the handling hazard, as well as reducing the chance for costly handling losses.

How to Select the Best Type of Blending

In analyzing the blending equipment needs for a given refinery, not every company will find the same conditions of equal importance. There may be cases where awkward location of tanks will make revision of existing piping so complicated that alterations are prohibitively expensive. Or, the production rate may be too low to justify installation of a continuous blender. Or, the number of grades of fuel produced and the delivery schedules are such that no further savings will result from adopting continuous blending.

But, in a refinery of any size, there are usually enough opportunities to save tankage alone that can justify a continuous blender. One major oil company has stated that in any new refinery continuous blending is a must.

In considering the adoption of a new type of gasoline blending system in any refinery, the following should be explored:

1—Is present tankage adequate for efficient blending?

2—Is dual rundown tankage available, or is product quality constant enough to justify a single rundown tank?

3—Is present tankage located so that separate lines and pumps for each component will not be too costly?

4—What is the nature of shipping schedules and ultimate delivery methods?

5—How many grades of gasoline are normally produced? Might this increase?

6—At what frequency are special grade fuels manufactured?

7—What percentage of finished gasolines are now reblended to avoid quality giveaway?

8—Is the number of operations already at an irreducible minimum—or can they be further reduced?

9—By more accurate blending, can the values in expensive components be better used?

Future for Continuous Blending

Automation of process units already has meant increased plant yield, improved operating efficiency, improved working conditions, safety, and product quality. All technological advances have been aimed at a minimum handling of the product, with a perfect balance between inflowing raw materials and outflowing finished product. Many gains have been made in reducing the need for intermediate product storage, which has resulted in less space, higher output and reduced capital outlay for new plants.

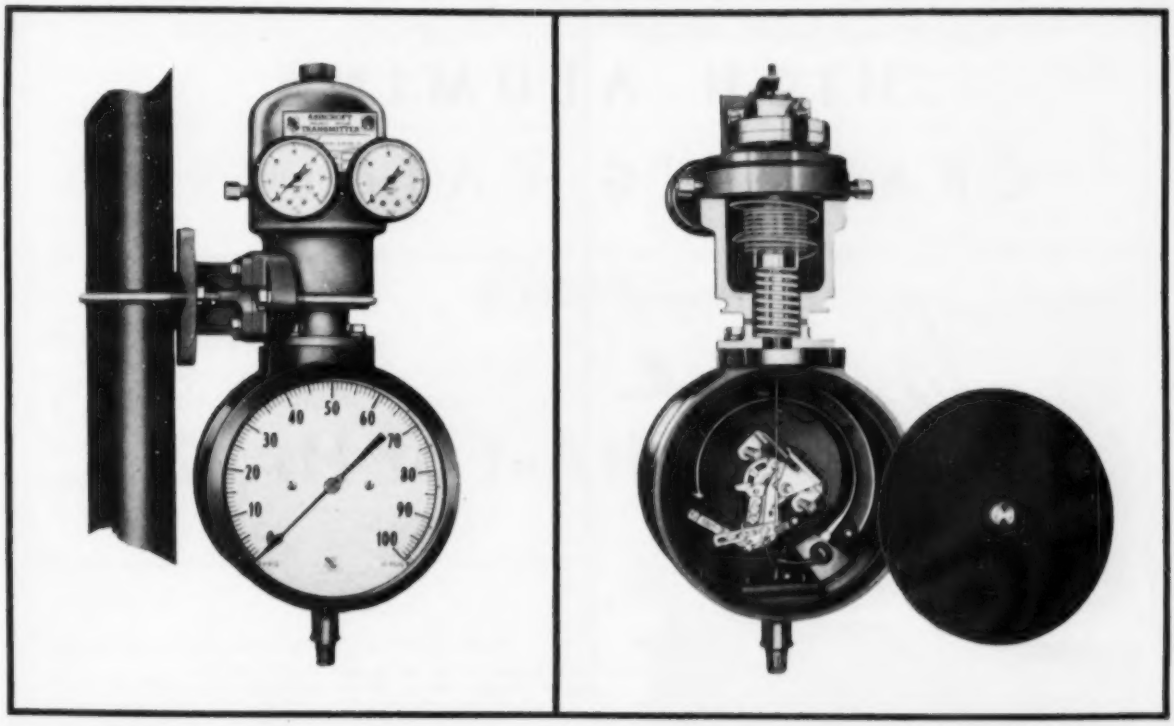
But, one large area left for improvement in product handling is the tank farm and light oil dispatching, blending and loading operations. Many steps toward instrumentation of these operations have already been taken: (1) automatic tank gauges with remote receivers, (2) remote temperature measurements, (3) remotely operated tank farm valves, (4) central location of all pumps and pump controls, and (5) continuous analyzers for product quality. Many engineers see in the future a completion of this picture through the use of data computers and electronic brains that will automatically analyze and control all operations.

The adoption of continuous blending of motor fuel is one of the last physical steps that will mean straight-through-handling of all refinery products, and elimination of the need for intermediate storage.

In meeting the demand for motor fuel in the next 1 to 20 years, refiners will want to take advantage of all techniques that will permit effective utilization of available manpower, raw materials and physical facilities. Continuous on-stream blending is one of the techniques that can help the oil industry effectively meet the demands resulting from expanding economy and population.

Designed to solve safety and service problems

...THE NEW ASHCROFT PNEUMATIC PRESSURE TRANSMITTER



This new Ashcroft Pneumatic Pressure Transmitter is particularly recommended to processing industries and power stations. It combines speed and accuracy with maximum protection and serviceability.

The new design features the 6" indicating Ashcroft Maxisafe Duragauge, long known for dependable performance. It has an integrally-cast solid metal wall between dial and pressure sensitive element so that the transmitter can measure pressures up to 100,000 psi with complete safety for personnel and equipment. If misapplication ruptures the Bourdon tube, the Teflon-coated back cover serves as a safety blowout relief.

Another outstanding design advantage is easy access to both gauge and transmitter sections. Simply remove the safety-relief back cover and both the gauge and transmitter can be calibrated. Yet a sealed housing makes the entire assembly weatherproof.

The transmitter operates on low-pressure air. No need for expensive high-pressure lines and fittings. Supply air pressure as low as 18-20 psi for 3 to 15 psi output provides especially advantageous operation where electrical wiring might be a hazard. Inflammable, poisonous or corrosive liquids or gases are confined close to their source, away from the central control point.

The Series 1250 Ashcroft Pneumatic Pressure Transmitter is available with pressure sensing elements in all standard pressure ranges and Bourdon tube materials. Installation of the transmitter is easy. Small diameter tubing may be used, and the pipe, stem, wall or flush mounts are interchangeable in the field. Get complete operational data and construction details. Write for Bulletin 340.

YOUR INDUSTRIAL SUPPLY DISTRIBUTOR has the broad knowledge and thorough experience essential to satisfy every requirement of your Ashcroft Pneumatic Pressure Transmitter application. You get fast, economical service from his local stocks.

In Canada: *Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario*

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MAKERS OF 'AMERICAN' INDUSTRIAL INSTRUMENTS, 'CONSOLIDATED' SAFETY AND RELIEF VALVES, 'AMERICAN-MICROSEN' INDUSTRIAL ELECTRONIC INSTRUMENTS, *Stratford, Conn.* 'HANCOCK' VALVES, *Watertown, Mass.* 'CONSOLIDATED' SAFETY RELIEF VALVES, *Tulsa, Oklahoma.* AIRCRAFT CONTROL PRODUCTS, *Danbury & Stratford, Conn. and Inglewood, Calif.* "SHAW-BOX" AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES, *Muskegon, Mich.*

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NATIONAL ALUMINATE CORPORATION
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(To obtain more data on advertised products see page 142)

Your Guide to ... Petroleum Processing Departments

Three Maintenance Tips for You

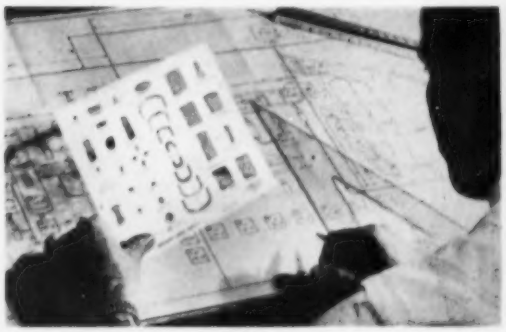
Shop hints in this month's Plant Practices include: 1 – How to use a process column as the support for a rigging boom; 2 – How to keep your gate valves from sticking; 3 – How to use a "king-size carpet sweeper" for tank cleaning. **p. 101**

Can We Serve Your Needs?

If you'd like more details information on a specific subject, turn to the Information Offered page. It's an easy-to-use, alphabetical index of data and literature offered in this issue's advertisements, telling you the page number. **p. 140**

Flow Through Restrictions

. . . is the subject of this month's "Clip-n-File" Engineering Data Sheet No. 4. It includes definitions, causes, methods of calculating pressure drop through pipe fittings, a table of "K" values, and a helpful nomograph. **p. 109**

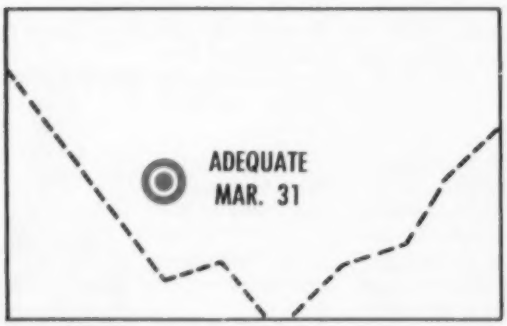


New Aid for Draftsmen

This layout template for graphic instrument panels can cut drafting room time in half because it has scaled outlines of the most frequently used instruments. See What's New! for this and dozens of other new ideas in equipment, supplies. **p. 145**

How Are Your Meeting Trip Plans?

The calendar for the busy oil man shows some important meetings coming up on the spring schedules. Check on your favorite technical society and its activities in this month's Meetings. Then make your plans so you won't miss anything. **p. 125**



"Targets" for Refiners' Stocks

As shown in the samples above, your Operating Trends now shows bull's-eyes on adequate stocks at critical dates ahead. Keep abreast of the current statistics each month on crude runs, and product output, supply, and demands. **p. 137**

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They're saving with these Crane valves on 850° F. draw-off service

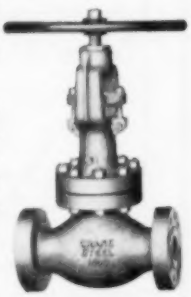
THE CASE HISTORY—What does it cost to keep a valve working? The answer can vary widely—as the DX-Sunray Oil Co. knows after long experience with Crane maintenance-saving valves.

For instance, take the 3-inch, 600-pound cast steel valves shown here. These No. 171X Crane globes were installed in 1945 on draw-off lines from reaction chamber. They handle oil at 850° F.

In 9 years' continuous service with frequent operation, these valves have cost no more than simple routine maintenance. They've shown no leakage, given no trouble of any kind. They're still as dependable as new.

Outwardly Crane valves look like many others. The difference that's important to you is mainly inside. It's in Crane's greater skill and care in casting steel—in developing Exelloy seating—in operating design—and in Crane's way of testing valves. That's why they give extra long, low-cost service.

Crane offers you complete selection in steel gate, globe, angle and check valves in all pressure classes—in sizes up to 24 inches.



For valuable help in specifying and ordering, call your local Crane Representative.

CRANE VALVES & FITTINGS

PIPE • KITCHENS • PLUMBING • HEATING

Since 1855—Crane Co., General Offices: Chicago 5, Ill. Branches and Wholesalers Serving All Areas

EXPERIENCE • SKILL • IMAGINATION

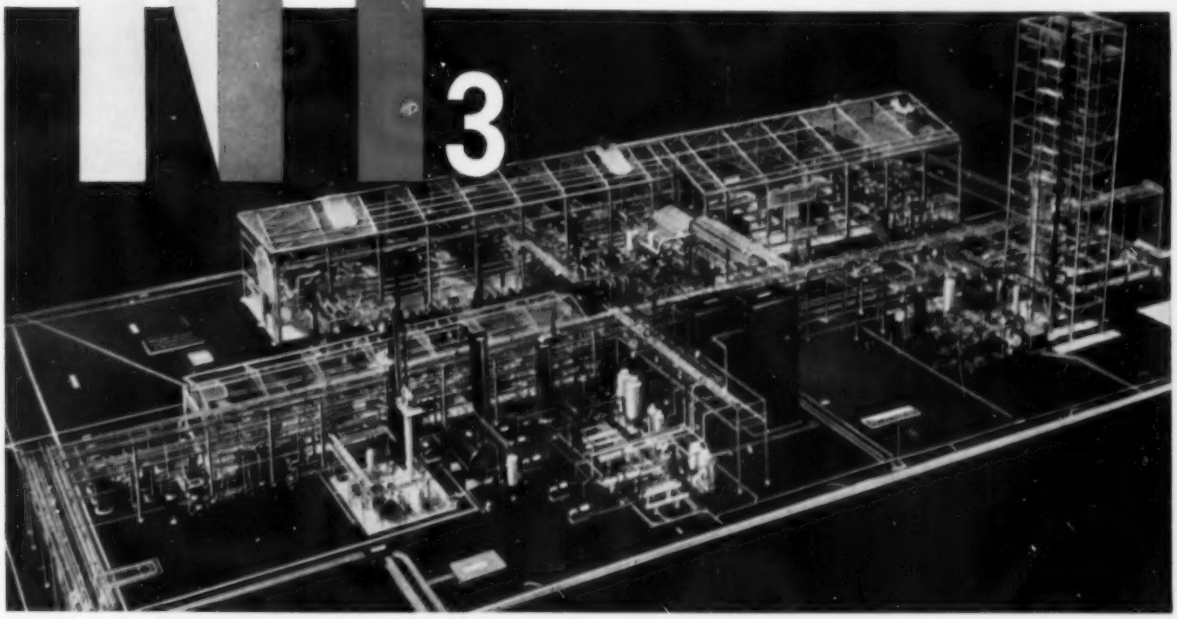
. . . are the foundations on which modern industrial achievement is built.

EXPERIENCE in the actual creation of multi-million dollar facilities . . .

SKILL as evidenced in expert design, engineering, and construction by a talented staff of trained men . . .

IMAGINATION to originate and develop new processes and new techniques.

NH_3



Imagination takes form in models. This model, made in advance of detailed design, was used throughout the engineering, procurement and construction stages of the job, and for the training of operators.

Catalytic experience, skill, and imagination put this modern 300 ton per day Anhydrous Ammonia Plant into service—ON TIME AND ON BUDGET.

With undivided responsibility, Catalytic completed process design, engineering and construction in 13 months.

CATALYTIC

CONSTRUCTION COMPANY

Philadelphia 2, Pennsylvania
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CATALYTIC CONSTRUCTION OF CANADA, LIMITED; SARNIA, ONTARIO

CATALYTIC *ON-TIME* . . . *ON-BUDGET* SERVICES for the metallurgical, chemical, petrochemical and oil refining industries: Project Analysis; Process Development; Process Design; Economic Studies; Engineering; Procurement; Construction; Plant Operation

1350

Since 1940

A record of installations

that in itself is incomparable

just as all Petro Chem Isoflow Furnaces

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(To obtain more data on advertised products see page 142)

DU PONT

PETROLEUM CHEMICALS DIVISION NEWS

DU PONT

April ★ One of a Series of Interest to the Petroleum Industry ★ 1956

Question Box

1. HOW MANY of your products can be protected against copper contamination?
   Count them in the article at right.
2. ARE YOU considering a new automatic component blending setup?
   If so, you will want to look into the service offered below.
3. WHO heads up the Du Pont Petroleum Laboratory?
   You'll "meet" him when you turn the page.
4. HOW CAN you be sure the heating oil you put into storage now will still be stable next winter?
   The information on the next page may help you make sure.

CONTINUOUS BLENDING OF GASOLINE COMPONENTS AND ADDITIVES

What advantages and dollar savings does it offer YOU?

If you are not already using partial or continuous on-stream blending, you may be considering the possibilities of setting up such an operation.

Users report that dollar savings which can be realized through these automatic methods may be substantial. And in today's highly competitive market, no one can afford to overlook any opportunity for cost reduction.

In many cases, facilities used in batch operations can be converted to partial on-stream blending by the addition of a relatively few pieces of equipment – such as pumps and recorder-controllers. A somewhat larger investment is generally required to set up equipment for continuous, automatic on-stream blending.

Before you take the step from batch to continuous blending, you may want to talk over the potentials and problems involved with an impartial consultant. Mr. B. G. Crane, Du Pont Petroleum Chemicals Division operations manager, will be glad to discuss it with you. During many years of work on all phases of additives blending, he has had the opportunity to observe the evolutionary development of continuous on-stream blending in numerous refineries. Because of this broad experience, his advice and help may be valuable to you.

For more detailed information on automatic blending procedures and how to select the type most practical for your own operations, you can get in touch with Mr. Crane at our Wilmington office, or call any of our sales offices listed on the next page.

Du Pont Metal Deactivator can improve MANY of your petroleum products

Du Pont technical services can help increase its value and usefulness to you

You have probably used a metal deactivator in your gasolines for some time . . . and are quite familiar with its effectiveness and advantages. But you may not be aware of the broad applications of Du Pont Metal Deactivator and its benefits which can be applied to many of the other petroleum products you make.

THE APPROVAL of metal deactivator for use in military aviation jet fuels further points up the versatility and broad usefulness of this Du Pont additive.

The list of the products which can be improved with Du Pont Metal Deactivator (DMD) includes diesel fuels, home heating oils, kerosines, jet fuels, turbine oils, greases and gasolines.

Technical services

To help you take advantage of the benefits of metal deactivator in all these products, Du Pont offers comprehensive technical services that are geared to your own individual needs and manufacturing operations. These services, which are coordinated through the Du Pont Petroleum Chemicals Division's five regional laboratories, can often help you put your whole additives program on a more economical basis. For example . . .

Because combinations of DMD with other Du Pont additives often work more efficiently than one additive alone, the Du Pont laboratory recom-

ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

OVER

DU PONT

PETROLEUM CHEMICALS DIVISION NEWS

DU PONT

CONTINUED *Metal Deactivator*

mendations can help you achieve your desired stability with less additive . . . often at a substantially lower treating cost.

For fuel oils

In diesel fuels and home heating oils, DMD helps prevent color deterioration and the formation of gelatinous sludge due to copper pickup from feed lines and fittings. And in many cases, it not only improves the storage stability of fuel oils, but also increases the effectiveness of other stabilizing additives used in conjunction with it.

In jet fuels

DMD has been approved by military specification (MIL-F-5624C) for use in jet fuels to inhibit deterioration, thereby decreasing fuel system plugging and residue formation.

Kerosines

In kerosines, DMD is useful as a color stabilizer in some copper-sweetened stocks. It has also been reported effective in reducing carbon and coke formation in pot burners by as much as 50%.

For greases, too

Since many greases, especially bearing greases, are likely to come in contact with metals containing copper alloys, adequate protection against copper contamination is vitally important. For maximum effectiveness in this application, DMD is frequently combined with a Du Pont grease antioxidant.

Are you realizing the benefits of using metal deactivator in all these products? If not, it will certainly pay you to discuss its use with a Du Pont Petroleum Chemicals Division representative. Or you can ask one of our conveniently located regional laboratories to test its effectiveness in your own stocks.

Because combinations of DMD with other Du Pont additives so often bring still additional benefits, our people are especially well-qualified to help you get the best results at the lowest possible cost. Just address your request to any of the sales offices listed below.

HEADS DU PONT PETROLEUM LABORATORY

DR. BERNARD M. STURGIS is director of the Du Pont Petroleum Laboratory, heading up all technical and customer service activities of the Petroleum Chemicals Division.

A native of Indiana he graduated with an A.B. degree from De Pauw University. Three years later he received his Ph.D. degree in organic chemistry from the Massachusetts Institute of Technology.

Then, in 1936, he joined the Du Pont Company as a research chemist at the Jackson Laboratory. In 1951 he was transferred to the Petroleum Laboratory as head of the combustion and scavenging division. He later became assistant director and finally director of the laboratory.

For his paper, "Some Concepts of Knock and Antiknock Action," he recently received the Horning Memorial Award in January 1956. This is the third time the Horning Award has been presented to a scientist from the Du Pont Petroleum Laboratory. It was previously awarded successively to Daniel L. Pastell and Leon F. Dumont for their work on precombustion reactions and combustion chamber deposits.

Dr. Sturgis is active in many technical societies and organizations, including the Combustion Institute, the American Chemical Society, the Society of Automotive Engineers, the American Petroleum Institute, and the Coordinating Research Council.

"Preventive medicine" now can reduce next winter's heating oil headaches

The chances are that you have started to put into storage your next winter's supply of home heating oil. But will it come out of storage as stable as it goes in?

You can be assured of the right answer to this question *now* . . . by adding Du Pont Fuel Oil Additive No. 2 (FOA-2) to your freshly prepared stocks at the refinery, before they go into storage.

Stabilizer and sludge dispersant—Filter clogging can be greatly reduced by the addition of FOA-2 because it not only stabilizes the fuel but also disperses any sludge that may already be formed — by reducing the size of the sludge particles.

Ashless — Many of your distributors' service calls may be caused by electrical failures due to a metallic ash coating on the electrodes and stack controls. Because it is ashless, Du Pont FOA-2 can help eliminate these wasteful service calls, too.

Avoid gel-clogged lines—By adding a small amount of Du Pont Metal Deactivator, you can also protect fuel from becoming contaminated by copper which is often used in heating system fuel lines. This will, in most cases, eliminate any danger of the lines becoming clogged by a gelatinous material due to copper pickup.

Ask us for samples.

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. . . through Chemistry

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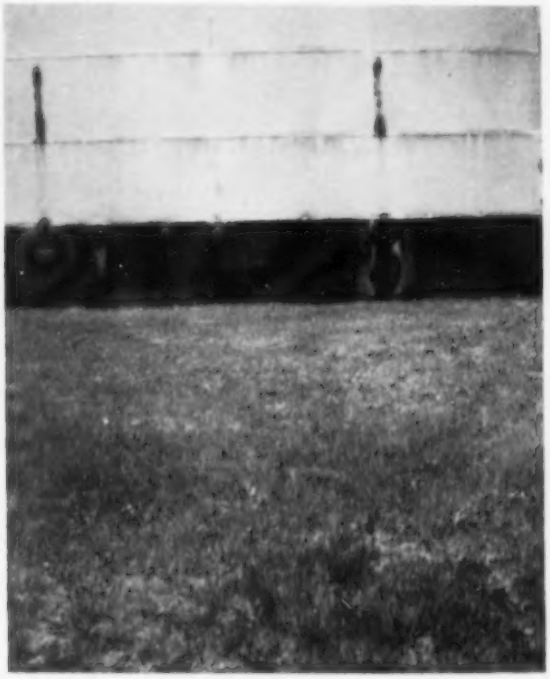


BEFORE area within fire wall was treated

AFTER chemical treatment of test plot in same area

Chemical Weed Killer Reduces Fire Hazard

CHEMICAL weed killers can not only reduce fire hazard in tank farms, but can do so at less cost than conventional weed control. Several years experience at the Sugar Creek, Mo., refinery of Standard Oil Co. (Indiana), has proved that the cost of chemical weed control can be as low as 40% of the cost of conventional mechanical and hand control.

The Sugar Creek refinery occupies 430 hilly acres on the banks of the Missouri between Kansas City and Independence. Tank farms are located along hillsides, with process units in valleys or on hilltops that have been levelled for them. Although the soil is mostly yellow clay it is sandy enough to make erosion a problem. Rainfall is seasonal and often heavy.

The tanks are located in fire-walled areas for protection of the process units. An enclosed volume at least equivalent to the volume of the tank is maintained, and so fire walls are often 10 to 15-ft. high. Inward and outward slopes vary from 30 to 45°. To prevent erosion fire-wall slopes are grassed, mostly with cultivated lespidesia. Within the fire wall the level areas must be kept free of vegetation, either by cutting or chemical control. Around the process units and along the pipe runs other level areas must be kept free of vegetation as a protective measure.

To maintain these conditions, some mechanical or chemical means of weed control are necessary on the firewall slopes. Where possible, the weeds are cut by power mowers to minimize cutting cost. Chemical weed control has been practiced where possible since 1950—each year seeing a greater acreage thus controlled.

Experimental work and actual experience have shown that the best chemical to use is poly chlorborate. It is usually spread as a dry powder early in the spring to act as a pre-emergence soil sterilant. Control in and around pipe runs, and touch up work, is done by spraying a mixture of TCA-2,4 D.

Poly chlorborate is used for three reasons:

1. Character of the soil—penetration of the chemical sterilizes a deep layer, killing deep rooted plants and seedlings as they sprout.

2. Early spring moisture—with application in February the spring rains can leach the chemical into the soil and sterilize it before growth appears. This avoids the fire hazard associated with dry grass that is chemically killed after emergence.

3. Persistent hold-over effects—yearly dosages decrease the amount and cost of application.

Chemical weed control started at the Sugar Creek refinery in 1950 with about six acres. Yearly increases have resulted in a total of 50 acres now under control.

The poly chlorborate powder is spread by motorized equipment over accessible acres, and by hand-operated devices over inaccessible places. Yearly applications have been reduced from 3500 lbs./acre in 1950 to 1800 lbs./acre in 1955. The kill is nearly 100%.

Standard Oil Co. (Indiana) is maintaining a continuous experimental program for evaluating new weed-control chemicals, seeking any economic advantages which might exist.

More 'Plant Practices' on page 102

LOOKING FOR

A DARN GOOD WIRE SCREEN

CORROSION-RESISTANT

Don't look no more—specify **CLEVELAND** Wire Screens for **YOUR** next installation.

Available in all corrosion-resistant metals and alloys, such as:

Stainless Steel
Monel
Nickel
Silver
Copper Alloys

CLEVELAND Wire Screens are designed for longer life and better service.

Woven to individual specifications for every purpose in any size or dimension, such as Vibrating Screen Sections, Filter Segments, Strainer Elements, Centrifuges.

WE CUSTOM BUILD

Filter Segments & Strainer Elements to your individual needs . . . in all commercial metals and alloys.

Easy to order—send us your requirements.

STRAINERS AND FILTERS

CUSTOM-BUILT

Custom-built and adapted to individual needs. Available in all commercial metals and alloys.

Write for Bulletin 6, 7, and 8

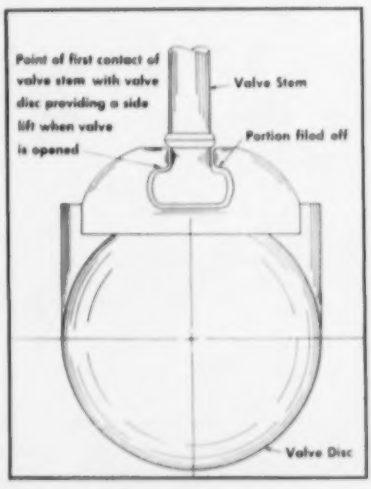
The CLEVELAND
WIRE CLOTH & MFG. Co.
3573 E. 79th St.

King-size Sweeper Eases Tank Cleaning Jobs

Normally, refinery street sweepers work outdoors cleaning driveways, parking and paved plant areas. But Esso Standard Oil Co. has developed a method of using standard street sweepers inside new storage tanks.

On new construction of 150 ft. diameter storage tanks, an opening is left at ground level. Through it is driven a street sweeper that mechanically cleans the bottom of the tank in some 45 minutes. All welding rod stubs, scrap metal and accumulated rubbish is swept into the machine, leaving the tank bottom "dinner plate clean." After the clean up the sweeper is driven out of the tank and the special opening sealed.

How to Eliminate Sticking Gate Valves


Point of first contact of valve stem with valve disc providing a side lift when valve is opened
Valve Stem
Portion filed off
Valve Disc

At Phillips Petroleum Co.'s Kansas City, Kans., refinery, considerable trouble was caused by the 4-inch hydraulic gate valves on the propane lines to the lube oil dewaxing chillers. These remotely controlled valves were sticking in closed position, often forcing the operators to open them manually. The unit was shutdown or put on circulation several times while repairs were made.

However, a slight physical alteration of the valve disc eliminated the sticking very effectively. 1/16-in. of metal was removed from the underside of one side of the slot used by the valve stem in lifting the valve disc. This small unevenness now provides a "side lift" action that twists the valve disc slightly before it is raised. The slight twisting action seems

(To obtain more data on advertised products see page 142)

the gas fork truck that makes the fewest and shortest trips to the maintenance shop...

BAKER "FG"

Industrial trucks "out-of-service" mean dollars down the drain... not only repair dollars, but even more dollars for lost work. That's why we loaded the Baker "FG" gas trucks with features that mean substantially more time on the job. Here are a few:

Heavy-duty industrial truck engine operates at optimum RPM for least strain and abuse. Pistons are balanced to grams instead of ounces, crankshaft to 4 inch-ounces, connecting rods to 2 grams. Compact, rigid "power train" requires no troublesome universal joints. Clutch housing is split for better accessibility. Single oil supply lubricates entire assembly. Large full-floating, self-equalizing, self-energizing brakes have single-point adjustment.

Baker "FG" gas fork trucks, available in 3000, 4000, 5000 and 6000 pound capacities, are the only gas trucks with a full 6-months' warranty... an added assurance. Write for specific bulletins.

Baker® -handling equipment

THE BAKER-RAULANG COMPANY

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A subsidiary of Otis Elevator Company

6G2

(To obtain more data on advertised products see page 142)

to be enough to break the disc loose before it rises.

This award-winning suggestion was submitted by P.A. Feist of Phillips Petroleum Co.'s Kansas City refinery.

Process Column Aids Maintenance

A PROCESS column can serve also as a structural support, and aid considerably in handling material within an area closely packed with other process equipment.

Shell Oil Company's Wood River refinery in Illinois has adapted a process column as a support for a long-reach lifting boom. Installed on a 57 x 9 ft. column it handles valves, exchangers parts and other equipment. Maximum permissible load is 2500 lbs.

Using this column-boom makes it possible to handle material in an area extending 31 ft. from the column, and covering a 200° arc—an approximate area of 1600 congested sq. ft.

●

Ideas for Dollars

Some things make sense—and others make dollars. Maybe you have something that can make both.

If you have any pet ideas that you want to share with others let us know. If they are worthy of publication—and you will be surprised how many are—they will be paid for at our regular space rates. Send us a description of that gadget you dreamed up, the one that works like a charm. And don't forget to send a sketch or picture if it may defy description. The address:

Plant Practices Editor
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That's why it pays you to use this hydraulic setting refractory for temperatures to 3000F

REPAIR old refractory linings—or build new ones—quickly and economically with Blazecrete*. For troweling, just mix Blazecrete with water as you'd mix ordinary concrete . . . then slap-trowel it in place.

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3X BLAZECRETE—For temperatures through 3000F. Unusually effective for heavy patching, especially where brickwork is spalled or deeply eroded. Excellent for forge furnace linings, lime kilns, burner blocks, soaking pits, and industrial boilers.

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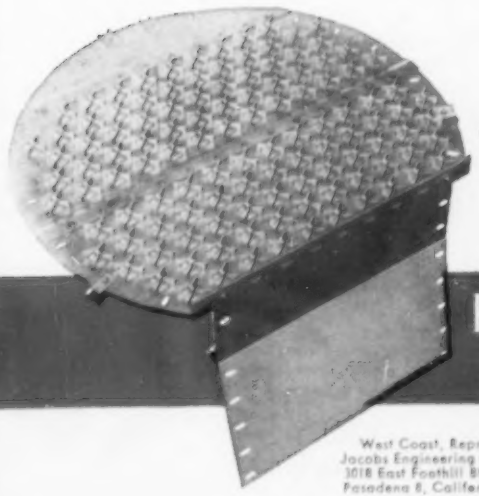

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Photo courtesy Standard Oil Co., (N. J.)

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For more complete details on what the Ljungstrom Air Preheater can do for you...for an analysis of the heat recovery benefits attainable in fuel burning equipment—call or write The Air Preheater Corporation.

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Do You Know These Words?

By B. H. WEIL
Manager, Information Services
Ethyl Corp. Res. & Engrg. Dept.
Detroit, Mich.

A regular department intended to help administrators and operating men alike keep abreast of technical names and processes in the petrochemical field.

Epoxy Resins

Epoxy resins are versatile, new materials which are petrochemically derived in every sense of the word. "Epoxy" (pronounced "ep-**ock**-sih") describes an oxygen atom attached to two different carbon atoms of the hydrocarbon chain, the simplest of which is ethylene oxide, $CH_2(O)CH_2$. Epoxy compounds containing ethylene oxide groups at both ends are capable of being polymerized not only into long-chain products, but also into cross-linked ones (where the chains themselves are linked together through reaction). Hence they can yield a variety of resinous materials.

This variety can be further intensified by use of different epoxy compounds, although the leading epoxy resins are produced from a monomer (plastic building block) derived as the reaction product of one molecule of bisphenol A with two molecules of epichlorohydrin (described in an earlier issue of this series). To yield resins of optimum strength and chemical resistance, the basic epoxy resins are "cured" by further reaction in the presence of any of several curing agents.

The epoxy resins yield fabulously strong adhesives, said to be capable of binding together almost any materials, with little or no heat and pressure. As surface coatings — paints, varnishes, etc.—they are both tough and highly resistant to acids and alkalies, hence are finding wide industrial application in addition to use in home appliances. They yield excellent glass-reinforced plastics, which is of considerable interest in the production of plastic pipe for transporting sour crude oils and oil-field salt water and for the production of tough tools and dies for stamping of metal parts.

As mentioned in the following item in this issue, bisphenol A is derived from cracked refinery gases and petroleum-reformate benzene. Epichlorohydrin, in turn, is a propylene (cracked gas) derivative, being produced as an intermediate (or coproduct) in one method for the synthesis of glycerine.

The epoxy resins, scarcely known 10 years ago, are today in the 50,000,000 lb./yr. class. Despite a slightly high cost at present, they apparently have an excellent future ahead of them.

Bisphenol A

Bisphenol A, pronounced "biss-**fee**-noll A," is a white (to brown) flaky solid with a mild phenolic odor. It melts at a temperature well above the boiling point of water (in which it will not dissolve) and has excellent heat stability. Its formula is $HO\text{-}C_6H_4\text{-}C(CH_3)_2\text{-}C_6H_4\text{-}OH$, which is the reason for one of its chemical synonyms, 2, 2-bis(4-hydroxyphenyl) propane; i.e., propane with two 4-hydroxyphenyl groups (phenol minus a hydrogen radical on the carbon atom opposite the -OH radical) attached to the middle carbon atom. "Bis," incidentally, means "twice—used as a direction to repeat."

Bisphenol A finds its chief and rapidly increasing use as a basic raw material in the production of epoxy resins. These resins are today finding a host of uses ranging from paints through glass-reinforced plastics to adhesives. Bisphenol A is also used as an intermediate in the manufacture of certain oil-soluble phenolic resins.

Bisphenol A is manufactured by the condensation of acetone ($CH_3\text{-}CO\text{-}CH_3$) with phenol ($C_6H_5\text{-}OH$), both of which are petrochemicals. As mentioned earlier in this series, phenol is produced petrochemically in several ways from reformate-derived benzene (including reaction with propylene from cracked refinery gases). Acetone is itself a propylene derivative, being produced either directly from propylene-derived isopropyl alcohol or as a byproduct in the production of phenol via the aforementioned benzene-propylene route.

Since the epoxy resins are being described as "skyrocketing" and "among the more promising of the new materials," bisphenol A will certainly be in increasing demand. That is why additional chemical producers are entering the field.

NEWS in VIEWS

SPECTACULAR COLLAPSE of 76-ft.-high burner at Tide Water Associated Oil Co.'s Avon, Calif., refinery will delay onstream date of 42,000 b/d fluid coker originally scheduled to go on line this August. Vessel collapsed under hydrostatic testing. Cause and cost are still unknown.

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Petroleum Processing's *Clip-n-File* ENGINEERING

Flow Restrictions in Pipe

THE PROBLEM: In calculating the pressure drop in a piping system the effect of the various fittings in the straight lines cannot be disregarded. In fact, the valves and fittings account for a greater pressure loss than would equivalent lengths of pipe. Their effect must be considered.

However, to calculate accurately the pressure drop in a piping system due to valves and fittings is not easy, nor absolutely necessary. Fitting losses in an average system constitute only a small part of the total pressure drop of the entire system. Even the pressure drop calculations for straight lengths of pipe is in the nature of an estimate, due to the many variables and changes in the pipe wall condition and fluid properties that cannot be forecast accurately.

In some cases it may be true that equipment piping is composed almost entirely of fittings. But in these cases any prediction of pressure losses from the following test data will be conservative. This will be true since the values discussed here have been determined by many experiments, all of which indicate maximum losses. When fitting follows fitting the total pressure loss is usually less than the sum of the two tested separately. This explains why a 180° return bend causes only four-thirds the loss of a 90° elbow, or slightly over twice the loss of a 45° elbow.

THE APPROACH: The pressure drop in a piping system can occur in one of three places: (1) a straight length of pipe, (2) a valve, or (3) a fitting. Valve losses may occur in either a gate or a globe valve, each of which has a different loss factor. By comparison it is the globe valve that offers the greater resistance to flow.

Fittings are classified as either branching connections (tees, crosses, etc.), reducers and expanders, or deflecting fittings (elbows, return bends, etc.). There are some special openings such as submerged discharges, venturi sections and others which will not be discussed.

THE CAUSE: Since all valves and fittings disturb the flow pattern in a piping system, and produce additional piping losses, let's consider how it occurs.

There are three component pressure losses associated with a valve or fitting that cause the total pressure loss. They are:

1. The loss of pressure occuring within the valve (or fitting) itself.
2. The upstream flow disturbance and pressure loss that would not otherwise occur. (This is small.)
3. The loss in the downstream piping caused by the presence of the valve. This additional effect is comparatively large.

By experiment it is the sum total of these three effects that is measured as the fitting loss. Although mathematical formulas have been proposed for calculating these losses, most of the recognized values today are empirically obtained.

CALCULATING FITTING LOSSES: Basically there are two recognized methods for expressing the pressure drop in valves and fittings, although each one is based on the fundamental relationship of Fanning's formula:

$$\text{Loss in head} = K \frac{v^2}{2g}$$

where: v = average flow velocity, ft./sec.
g = acceleration due to gravity, 32.2 ft./sec.
K = velocity head factor, experimentally determined.

In the first method, the excess loss in pressure due to a valve or fitting is expressed as lost head in ft. of fluid. The coefficient "K" is practically constant for any type of valve or fitting and is selected from the following table of approximate values.

Values of "K" in Pressure Loss Calculations

Valve or Fitting	Value
Globe valve (fully open)	10.0
Angle valve (fully open)	5.0
Swing check valve (fully open)	2.3
Close return bend, screwed	2.0
Standard tee, screwed	1.8
Standard tee, welded	2.4
Standard elbow, screwed	0.9
Standard elbow, welded	3.1
Medium sweep elbow	0.75
Long sweep elbow	0.60
45° elbow, screwed	0.42
45° elbow, welded	0.21
Gate valve (fully open)	0.20
¼ closed	1.2
½ closed	5.8
¾ closed	24.0
Sudden enlargement:	
$d_1/d_2 = ¼$	0.92
$d_1/d_2 = ½$	0.56
$d_1/d_2 = ¾$	0.19
Ordinary entrance	0.5
Sudden contraction:	
$d_2/d_1 = ¼$	0.42
$d_2/d_1 = ½$	0.33
$d_2/d_1 = ¾$	0.19

A second method expresses the pressure loss due to fittings or valves as equivalent diameters of straight pipe. The relationship is expressed as:

$$L_e = n\,d$$

where: L_e = equivalent excess length of a fitting or valve, in feet
n = number of equivalent pipe diameters, empirically determined
d = inside diameter of pipe, in feet.

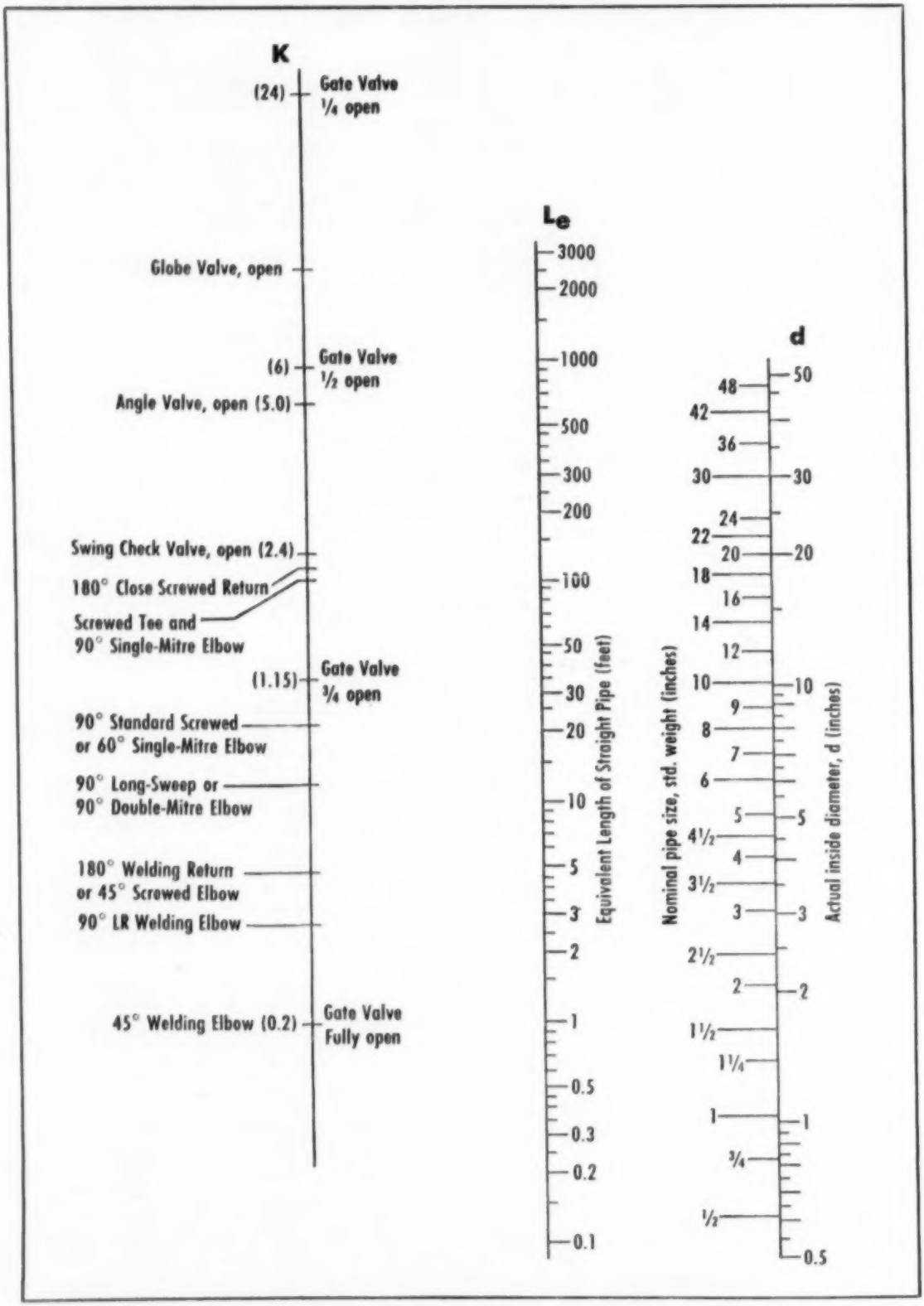
This second method is an older one and not used as often as the more accepted "coefficient of resistance" method, which assumes the excess loss to be a direct function of the velocity head and independent of the friction coefficient.

More recent investigations suggest that perhaps the value of "K" may vary with the friction coefficient to some extent, especially for sharp radii and turns. But since there are so many variables encountered in the design of a piping system that cannot be accurately evaluated, it is not felt necessary to strive for extreme accuracy in this one phase of the calculations.

It is important to realize, however, that the above procedures apply primarily to turbulent flow, which is encountered in most industrial installations. Data on fitting losses in the laminar range are very meager, but even there the assumption of a constant velocity head is reasonable. In laminar flow, K is roughly four times as great as for turbulent flow for elbows and bends, and up to 1⅓ times as great for tees and valves.

For More Data, Turn the Page . . .

● FLOW RESTRICTIONS for Valves and Fittings



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Second, make use of the materials supplied by the Oil Industry Information Committee. For instance, the OIIC has many informative and entertaining movies which are offered without charge. Why not arrange to have one of them shown at your local clubs or schools or anywhere you might find an audience. You'll find, as other oilmen have, that doing this not only helps you and your industry, but also gives you a great deal of personal satisfaction.

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(To obtain more data on advertised products see page 142)

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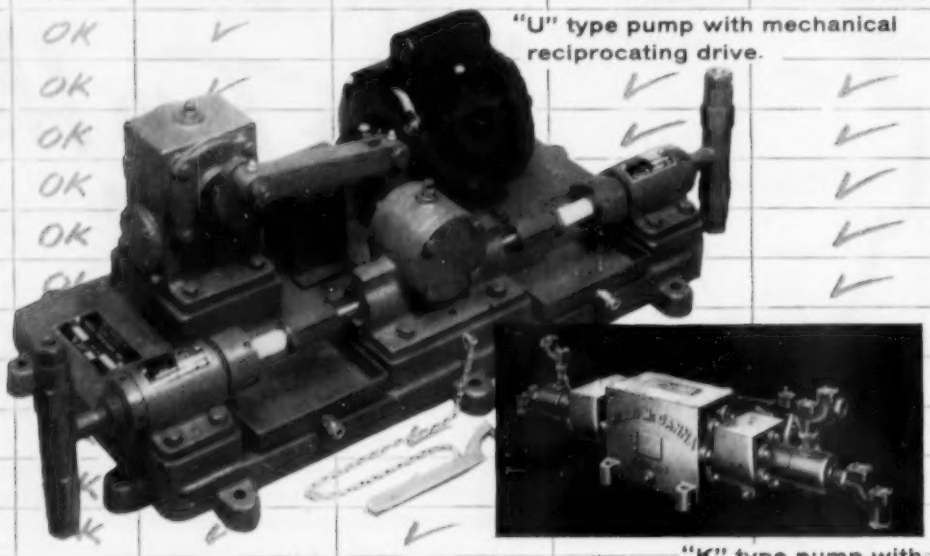
PUMP MAINTENANCE REPORT

MONTH	CHECK	VALVE	STROKE	PLUNGER	LUBRICATION
JANUARY	OK	✓			
FEBRUARY	OK	✓		✓	✓
MARCH	OK			✓	✓
APRIL	OK				✓
MAY	OK				✓
JUNE	OK				✓
JULY					
AUGUST					
SEPTEMBER					
OCTOBER	OK				
NOVEMBER	OK	✓	✓		
DECEMBER	OK	✓	✓	✓	



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Maintenance reports from the leaders in many different industries prove the low-cost operation of Hills-McCanna metering and proportioning pumps . . . tell why these pumps are specified for installations requiring the finest equipment. Part replacement is remarkably low because there are few points of wear. Routine maintenance is simple and economical thanks to special Hills-McCanna features, such as separate interchangeable check valves and easy, precise stroke adjustment (even while in operation when desired). Working parts are completely enclosed to keep them dirt-free. All U Type pump bodies are interchangeable in the housing for quick convertibility. Straight reciprocal drive eliminates bushing replacement. And, you'll find Hills-McCanna pumps mighty easy to install.

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William M. Holaday, coordinator of new product planning for Socony Mobil Oil Co., has become Deputy Assistant Secretary of Defense for Research and Development and is on leave from Socony Mobil.

Manager of Socony's East St. Louis, Ill., refinery, **Oliver C. Johnson,** has been appointed assistant general manager of the manufacturing department in New York. He has been succeeded at East St. Louis by **Harry A. Lutz,** formerly assistant to the refinery manager.

Ray R. Irwin, area manager of refineries, pipelines and crude supply, with headquarters in Kansas City, has retired. He was in the oil industry for some 46 years and was at one time president of the White Eagle Oil Corp. until that firm was purchased by Socony.

Howard F. Thompson has been promoted to resident engineer of Sinclair's Marcus Hook, Pa., refinery. He succeeds **John C. Weber,** who is retiring after 32 years with the company.

Mr. Thompson

Thompson became chief inspector in 1942, chief technician in 1945, and operating superintendent in 1952. Weber joined Sinclair in 1924 as a draftsman. This was during construction of the Marcus Hook refinery. A year later he was put in charge of all engineering at the plant.

Dr. William P. Hettinger, Jr., has been appointed director of the catalysis division of Sinclair Research Laboratories, Harvey, Ill. He began with the company in 1950 as a research chemist in the division and later became its section leader in organic chemistry.

E. C. Cyr, research and development engineer in perchloroethylene manufacture at Dow Chemical Co.'s Houston plant, has been promoted to planning engineer. He has been with Dow since 1951.

George P. Bunn, manager of the natural gasoline department of Phillips Petroleum Co., has been given the newly created position of executive staff assistant on natural gas liquids. Bunn's old post, which he has held since 1930, has been given to **G. W. McCullough,** who moves from chairman of the Phillips operating committee. McCullough has also been a vice-president since 1953.

The new operating committee chairman is **J. M. Houchin,** who was general superintendent of the production department. **Harry Fair,** who retains the post of vice-chairman of the operating committee, has been given the new responsibility of chairman of the product and process committee.

Mr. Russell

Mr. Loosli

George W. Russell has been promoted to general manager of American Cyanamid Co.'s industrial chemicals division. His former post, assistant general manager, has been given to **Alden R. Loosli,** who was assistant general manager of the fine chemicals division.

Gen. Anthony C. McAuliffe will join the company to head the newly created engineering and construction division. He has retired from the U.S. Army and will begin his new post on May 1. The division has equal status with operating and research divisions of American Cyanamid, and, in his new post, General McAuliffe will be president of its engineering subsidiary, the Chemical Construction Co.

A. H. Hayes, general superintendent of the Standard Oil Co. (Ind.) refinery at Whiting, has been given the new title of senior assistant manager at the refinery.

At the Wood River, Ill., refinery, **Dr. F. H. Blunck** has been promoted from general superintendent to the new position of manager of the unit operations division, in the Chicago general office of the manufacturing department.

L. H. Butterworth, formerly general superintendent at the Casper, Wyo., refinery, has been transferred to Wood River with the new title of assistant manager.

In Standard's research department, **Samuel Kahn** has been appointed a patent advisor at Whiting. **Dr. W. J. G. Cudmore** has been named group leader at the Mandan, N.D. laboratory.

Herman L. Boyle has been made manager of the company's newly created organization department. He is succeeded as director of employee relations (formerly known as industrial relations) by **J. Howell Turner.**

Robert E. Maescher has been appointed assistant to the superintendent of General Petroleum Corp.'s Torrance refinery. He has been with the company since 1938.

A new section leader at Torrance is **Paul M. Wilkins,** who has been with General Petroleum since 1946.

Robert W. Wiese has been made job engineer at the refinery. He joined the company in 1946 and for the past two years has been with an affiliated company in Australia.

W. J. Anderson, formerly general foreman of the crude and coking department of Standard Oil Co. (Ind.), Sugar Creek, Mo., has been with Commonwealth Oil Refining Co. in Ponce, Puerto Rico, since the fall of 1955. He works as process superintendent at the Ponce refinery.

Bill Cummings, formerly assistant department manager, E department, at Shell Chemical Corp.'s Houston plant, has become manager of the ammonia department at Shell Point.

Cummings succeeds **L. L. Baldwin,** who is in Europe on special assignment.

R. E. Coslett has been made manager of the shipping department at the Martinez chemical plant, replacing **I. B. Wilson,** who has been transferred to the shipping department at Shell Chemical's Houston plant.

Nilon H. Prater has been employed as a chemical engineer in the process design department of the Chemstrand Corp.'s Decatur, Ala., headquarters. Previously he was with Magnolia Petroleum Co.

Serge B. Jurenev has been named assistant to the president and chief economist for Continental Oil Co. He has served on various economic, financial and planning committees of the API, IPAA and the Mid-Continent Oil & Gas Association.

Paul Bermingham has been elected a director and appointed general coun-

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GAGE ILLUMINATORS

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sel of General Petroleum Corp. **James A. Grace** has been named secretary. Bermingham and Grace succeed **Don W. Woods,** who recently retired after 40 years of service.

Dr. Rush F. McCleary has been appointed general manager of Jefferson Chemical Co.'s research and development department. He comes to Jefferson from The Texas Co., where he worked for 16 years. His last post with Texaco was a supervisor of chemical research.

Kenneth G. Mackenzie, formerly with The Texas Co. and now a private consultant, was cited recently by the American Standards Association for his work towards the establishment of American standards. He is a member of the Standards Council of the ASA, serving as a representative of the American Society for Testing Materials, of which he is past president and an honorary member.

John S. Pfarr, vice-president and director of Leonard Refineries, Inc., has been named administrative head of the manufacturing department. **T. J. Williams** will manage Roosevelt Oil & Refining Division. **Everett Thompson** will direct Mid-West Refineries Division. **Robert Pollard** will be in charge of Leonard Refineries Division.

Edward J. Nopper has been appointed chief electrical engineer for Sun Oil Co.'s manufacturing department. He has supervision of the electrical distribution systems at the company's three refineries.

Eugene Holman, chairman of the board of Standard Oil Co. (N.J.), has been elected 1956 chairman of the Commerce Department's Business Advisory Council. He succeeds Harold Boeschenstein.

Elwood G. Glass, Jr., has been named coordinator of recruitment for Standard Oil Co. (Ohio), with his headquarters in Cleveland. For the past 16 years he has held various positions in manufacturing.

Robert S. Kestner is now a group engineer in the construction section of the manufacturing department at Cleveland. Kestner began with the Sohio Pipe Line Co. in 1947.

Doctors Donald C. Emrick, Wilfred B. Howsmon, and **James D. Idol** have joined the chemical and physical research division in Cleveland. Emrick will work on mobile power oils and industrial products projects. Howsmon has been assigned to basic research. Idol will work on petrochemicals and microballoons in the research division.

H. A. W. Kidd has been made assistant to the manager of Magnolia Petroleum Co.'s natural gas department. For the past three years, Kidd has been assistant to the director of Socony Mobil laboratories, with headquarters in New York. Before that time he spent nine years at Magnolia's field research laboratories in Dallas.

Mr. Waltermire

Mr. Ryan

Frank Waltermire, head of the supply and distribution department at Esso Standard Oil Co.'s Bayway refinery, has been assigned to the refining coordination division of the manufacturing department, with offices in New York. His post at Bayway has been taken by **Barney Ryan,** who was head of the economics and design division in the technical department. This job has now been assumed by **Ed Gangluff,** head of the planning section in the division.

A new post as assistant head of supply and distribution is being filled by **Frank Walsh,** former economics analyst for the East Coast Manufacturing Division.

Gangluff's old post as head of the planning section has been given to **Jack Bell,** and **Hank Smithers** has replaced Bell as group head in project engineering. **Bill Sparks** has taken Smithers' post of region supervisor in the mechanical department's maintenance division, leaving his job of general foreman of the welding department to **Pete Buckley.**

In the technical service division, **Ed Juterbock** has moved from the post of assistant division manager to the newly created job of assistant head of the Bayway technical department. His former position has been assumed by **Jack Gardner,** section head of the division's economics.

Herb Minich has joined the technical service division. He has been replaced as additives department head

(To obtain more data on advertised products see page 182)

For thermafor catalytic cracking units

Stainless Steel

resists 860° F., 15 psig oil vapors

How different refineries would be without Stainless Steel! And how much *more* they would cost to operate! Almost every time you find a high temperature, corrosive situation, you find lots of Stainless Steel.

In the unit shown here, the reactor chamber is lined with 7/64" type 410 Stainless. Reactor internals, bubble caps and trays and various vessel linings are also made from Stainless Steel. These are decisive steps to reduce the continuing high cost of refinery plant corrosion.

When *buying* Stainless Steel, remember that United States Steel offers the widest range of sizes, grades and types. Selection is easy, and you can be sure of service-tested USS quality.

El Dorado, Arkansas refinery of Lion Oil Company, a division of Monsanto Chemical Company.

SEE The United States Steel Hour. It's a full-hour TV program presented every other week by United States Steel. Consult your local newspaper for time and station.

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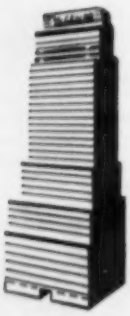

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by **Jim Fennell,** formerly head of the technical products lab. This post has been taken by **Roly Clark,** and **Phil Thomas** has succeeded him as head of that lab's experimental group.

Ernest Jacobsen has taken over the job of supervising engineer in Esso Research and Engineering Co.'s procurement section, succeeding **Fred Eberle,** who is completing a special assignment before his retirement next October.

Jacobsen's job, assistant supervising engineer in the section, has been given to **Frank Martin,** formerly group head in the mechanical engineering section of design.

Woody Brown has been named a section head in the petroleum development division. He succeeds **Ed Gornowski,** who recently became the division's assistant director.

E. J. Fox, assistant works manager of Carbide and Carbon Chemicals Co., has been made a vice-president in a new division of the parent Union Carbide and Carbon Corp. The division is the Union Carbide Development Co. and its responsibilities include long-term corporate planning and evaluation of new business opportunities.

Fox has been with Union Carbide since 1930. From 1952 to 1955 he was superintendent of the Chemicals Co.'s Texas City plant. He became assistant works manager in 1955.

Other vice-presidents in the new company are **R. E. Cornwell** and **J. J. Murphy. Birny Mason, Jr.,** secretary of Union Carbide, is president.

Preston D. Phillips, Jr., chief engineer at Humble Oil & Refining Co.'s Baytown refinery, has been made assistant general superintendent. **Frank O. Stivers,** assistant chief engineer, has succeeded Phillips.

In research and development, **J. H. Karchmer** has been promoted to research specialist. **S. O. Brady** has been made senior research chemical engineer.

M. F. Jennings has been named general foreman of the boilermaker-blacksmith-sheet metal department in the refinery.

George S. Lambert has been named director of the plant personnel division of the Atlantic Refining Co. He is responsible for personnel activities at Atlantic's Philadelphia and Atreco refineries, the research and development department in Philadelphia, and the marine and other special transportation employe groups.

Jordan Enters Chem Consulting

W. Alec Jordan, formerly editor-in-chief of McGraw-Hill Publishing Co.'s *Chemical Week*, has entered practice as a chemical business consultant. His offices are at 270 Park Ave., New York.

Prior to entering the editorial field, Mr. Jordan had extensive experience in technical service and chemical sales management. He will specialize in market development, product promotion and related chemical business problems.

Tenamene Now in Tank Car Lots

Tenamene 2, a gasoline gum inhibitor, may now be shipped to refiners in tank car quantities, according to Eastman Chemical Products. Until now, shipment in drums was the only method considered both safe and likely not to affect the quality of the phenylene diamine type additive.

Development of a special tank car and unloading station by Eastman engineers has solved the problem and permits delivery in the more economical tank car quantity.

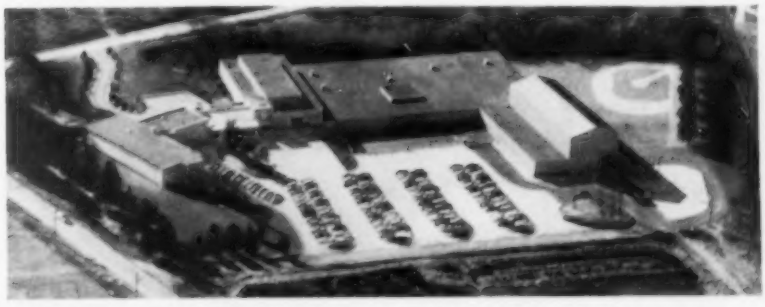
The new unloading system actually has three versions, which give greater convenience to customers with varying plant situations.

ONE MILLION of these 50-lb. bags of cracking catalyst have been turned out at the Houdry Process Corp. Paulsboro, N.J., plant. Jack C. Dart, general manager of the chemicals division, left, and Ray Cross, manager of manufacturing, center, present bag No. 1,000,000 to C. G. Kirkbride, president of the company.

Ultrasonics Group Formed

The new and rapidly growing field of ultrasonics will be represented by the recently formed Ultrasonic Manufacturers Association. Officers for the first term are as follows: president, W. C. Pothoff, vice president of Aeroprojects, Inc.; vice-president, Stanley R. Rich, technical director and vice-president of General Ultrasonics Co.; secretary, Norman Branson, president of Branson Instruments, Inc.; and treasurer, Jack Welch, general manager, machine tool division, of the Sheffield Corp.

The interests of the organization will be furthered by (1) the dissemination of information about ultrasonic equipment and applications, (2) promotion of new applications, (3) adoption of ethical practices in sales, publicity and advertising, and (4) aid to members in their dealings with governmental agencies, especially in securing clear and realistic rulings from such bodies as the Federal Communications Commission.



NEW HOME OF SELAS CORP. is just north of Philadelphia, in Dresher, Pa. Research, design, and manufacturing of Selas products—fluid processing equipment—are centralized at the plant. Good roads and a spur of the Pennsylvania Railroad service the 11-acre site. An internal dial phone system and pneumatic tubes link all departments.

Constructors Elect New Officers

C. D. Haxby, vice-president of Rust Engineering Co., has been elected 1956 president of the National Constructors Association. He succeeds T. C. Williams, president of Stone & Webster Engineering Corp.

Carl B. Whyte, president of Procon Inc., was elected vice-president of the association. New members of the executive committee are Paul S. Klick, Jr., Foster-Wheeler Corp.; G. I. Seybold, Chemical Construction Corp.; and H. A. Denny, Koppers, Co.

Rockwell Buys Metal Firm

Rockwell Manufacturing Co. has purchased the Locomotive Finished Materials Co. at Atchison, Kan., a plant with the largest steel foundry and machining facilities west of the Mississippi River.

The 84-year-old firm is the largest Rockwell acquisition since the purchase of Delta Manufacturing Co. 11 years ago. LFM Co., as it is sometimes

known, casts, machines, and assembles equipment for the petroleum, railroad, machine tool, mining, power and other industries.

The acquisition will bring Rockwell's volume of sales in 1956 to more than $105 million and will add about 1000 employees to the company's payroll. LFM Co. will be operated by its present management as a major division of Rockwell.

Klein Becomes Catalytic V-P

George F. Klein, Jr., has been appointed vice-president in charge of engineering and elected to the board of directors of Catalytic Construction Co.

Mr. Klein has been chief engineer since September, 1955, prior to which he was manager of the process engineering department. Before joining Catalytic, he was chief engineer of Spencer Chemical Co. and held supervisory positions with the National Aniline Division of Allied Chemical & Dye Corp. and Hercules Powder Co. He also served as chief engineer of the Refinery Engineering Co.

Mr. Klein is a graduate of the University of Missouri, where he obtained a B.S. degree in chemical engineering. His home is in Gladwyne, Pa.

Mr. Springer

Mr. Pitcher

Graver Promotes Two

The new post of director of research and development at Graver Tank & Manufacturing Co. has been given to Charles W. Springer, vice-president of the firm and for some years head of eastern sales.

H. C. Pitcher has been named general manager of Graver Construction Co., subsidiary of Graver Tank.

Before joining Graver, Mr. Springer was with Draper Manufacturing Co., Chicago Bridge & Iron Co., Jones & Laughlin Co., and several military departments of the U.S. Government.

Mr. Pitcher was construction manager of M. W. Kellogg Co. before the went to Graver Construction Co. He has had more than 20 years' experience in building industrial plants throughout the U.S.

New Additives Group at Du Pont

A new additive sales group has been formed in Du Pont Co.'s Petroleum Chemicals Division. Personnel have been seleted largely from the company's petroleum laboratory staff.

Mr. Mikita

J. J. Mikita, who will be sales manager of the additives group, was director of the lab. This post will be taken by Dr. B. M. Sturgis, formerly assistant director. New assistant directors are R. O. Bender,

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Trade Mark Reg. U.S. Pat. Off.

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- Prevention of Pollution by Refinery Wastes.

ANTHRAFILT can be used in any filter requiring a filter media. Get the benefit of higher rates, longer runs and lower backwash requirements, along with a better quality of filter effluent.

ANTHRAFILT, being essentially a pure carbon, is not affected by acid or alkaline solutions.

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FIG. 8 IRON
FIG 8SS STAINLESS

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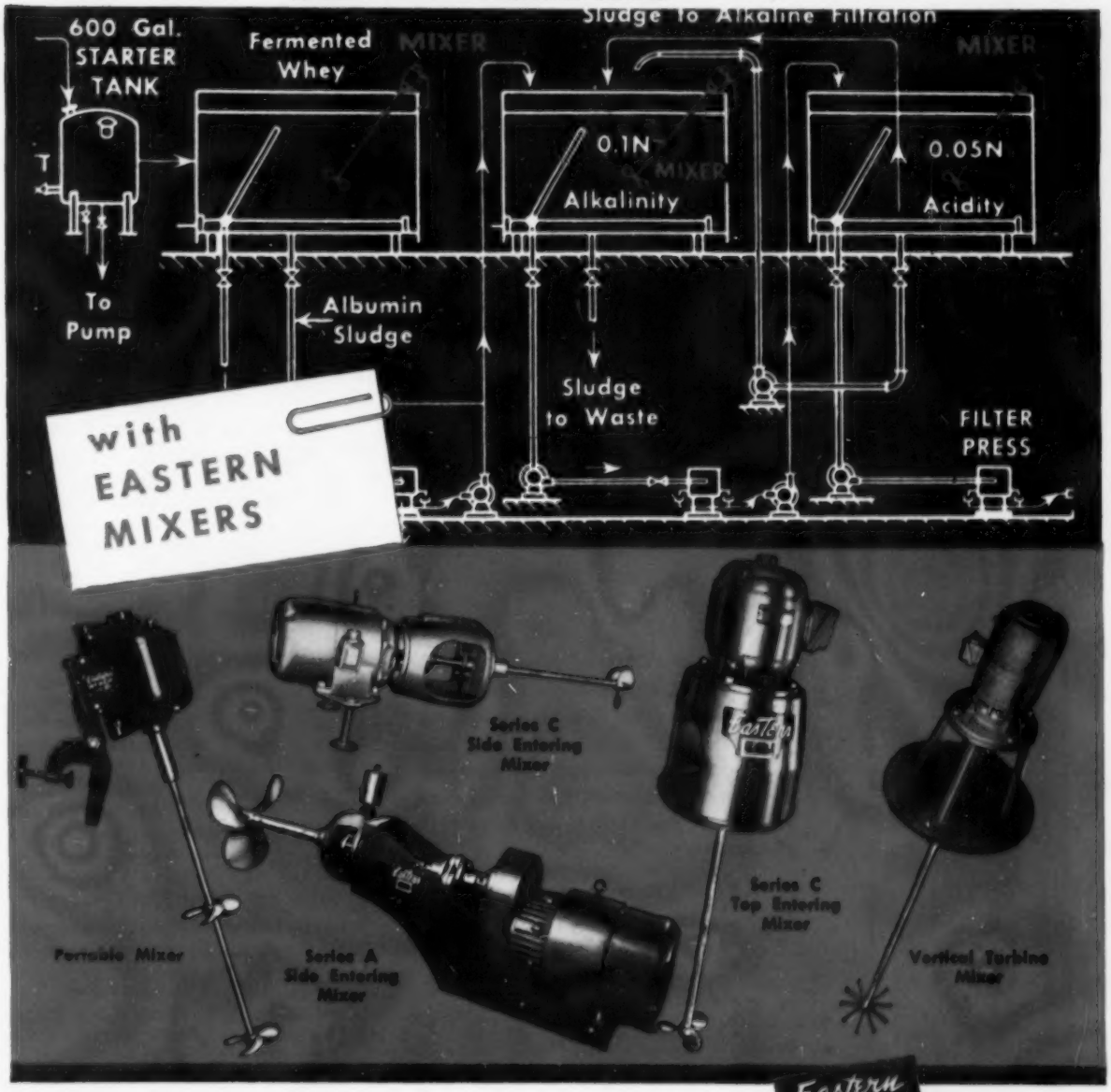
Phone Livingston 6-1400
ERNST WATER COLUMN & GAGE CO.
LIVINGSTON, N. J.

(To obtain more data on advertised products see page 182)

RELIABLE FLUID MIXING in PROCESSING



Eastern's Mixers are designed to meet the needs of today's chemical and industrial processes. Many types are available to satisfy all conditions of fluid consistencies and tank sizes. Selection may be made from a wide range of horsepower, speed, and construction materials. Motors with various voltage ratings and enclosures are also furnished.

PORTABLE MIXERS

Series H at 1725 R.P.M., Series S at 1125 R.P.M., and Series G at 420 R.P.M. are available in motor ratings from 1/20 to 5 H.P. Also available are special speeds, variable speeds, as well as air driven models.

TOP AND SIDE ENTERING

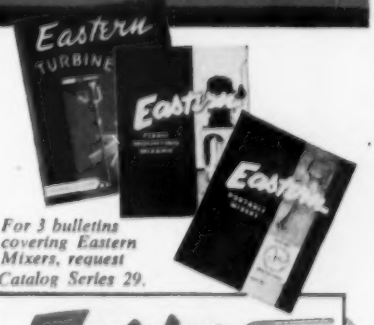
Series A, extra heavy duty for large tanks, are available in side entering units only within a range of 5-30 H.P. with standard speeds of 280, 420, and 1150 R.P.M.

Series C, for average tank capacities, are available in sizes of ¼ to 10 H.P. at these standard speeds: 1725 R.P.M. (up to 5 H.P.); 1140 R.P.M. (up to 10 H.P.); 420 R.P.M. (up to 7½ H.P.); 280 R.P.M. (up to 5 H.P.). Available in both horizontal and vertical models.

TURBINE MIXERS

Eastern's Top and Bottom Entering Turbine Mixers find particular application where liquid blending requires gentle, yet thorough agitation.

Models are available in sizes from ¼ to 40 H.P. Standard speeds are 56, 68, 84, 100, 125, 155 R.P.M.

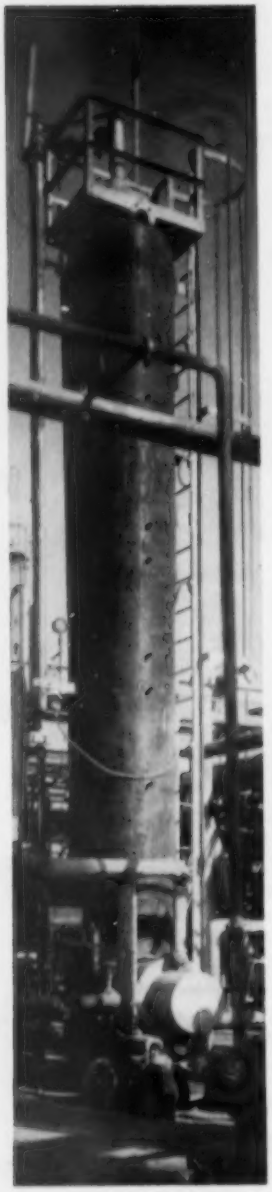


For 3 bulletins covering Eastern Mixers, request Catalog Series 29.

Eastern INDUSTRIES, INC.
Mixer Division
Regent St.,
Norwalk, Conn.

(To obtain more data on advertised products see page 142)

Now you get Double-action cleaning on Double-trouble jobs with OAKITE COMPOUND No. 85



Those tough soils built up on refinery equipment are doubly tough to clean – a solvent is needed for removing carbon deposits, and then an acidic cleaner for iron oxides and sulphides.

Now, with new Oakite Compound No. 85, you can do both jobs at the same time – remove carbon *and* iron oxides and sulphides in a single cleaning operation on absorbers, debutanizers, de-ethanizers, feed stock pre-heaters, heat exchangers, stabilizers. And O.C. 85 has these extra advantages:

- Fast soil penetration
- Does not attack steel
- Long-lasting solution
- Rinses freely
- Safer than raw acids

Ask your local Oakite Technical Service Representative to show you how Oakite Compound No. 85 can save you considerable off-stream time. Or write for Bulletin F3751 to Oakite Products, Inc., 50D Rector Street, New York 6, N. Y.

OAKITE

Export Division Cable Address: Oakite

Technical Service Representatives in Principal Cities of U. S. and Canada

in charge of technical service, and R. H. Blake, product evaluation.

Mr. Mikita will have as his assistant W. W. Wingate, formerly in the division's product development group. Manager for additives in the eastern region, with New York as his headquarters, will be W. E. Bettoney, who leaves the petroleum lab as assistant director.

Additives manager for the central region will be N. D. Lawson, who has been head of the lab's fuels and lubricants section. He will work out of Chicago. J. B. Malin will take the same post in the western region, where he has been regional laboratory manager.

Kern Forms Consulting Firm

D. Q. Kern Associates is a new consulting firm specializing in the design, engineering and marketing of thermal process components. Formed by Dr. Donald Q. Kern, the organization has its main office at 7016 Euclid Ave., Cleveland, and branches in New York and Washington, D.C.

Dr. Kern

The associates are five men in the fields of distillation, high pressure techniques, nuclear engineering, heat transfer, and thermodynamics.

Dates for Ansul Fire Classes

The annual fire-fighting school given by the Ansul Chemical Co. at Marinette, Wis., has scheduled the following sessions:

May 21-23; June 4-6, 11-13, 18-20, 25-27.

July 9-11, 16-18, 23-25; July 30 to August 1.

August 20-22, 27-29; September 17-19, 24-26; and October 8-10.

Classes are limited to 25 persons. Instruction is given in fighting flammable liquid and propane gas fires of all sizes and types and with the latest hand, wheeled and stationary equipment.

Personnel Changes

Houdry Process Corp.—Henry D. Noll, formerly director of engineering, to director of foreign operations for the process and chemical divisions.

Pfaudler Co.—Alton L. Gray to assistant general sales manager; Edgar N. Fox, Jr., to Rochester district sales manager, succeeding Gray; Robert C.

(To obtain more data on advertised products see page 142)

IF YOU ARE CONCERNED WITH HIGH OCTANE OPERATIONS

INVESTIGATE THE EXTRA EFFICIENCY OF Sinclair-BAKER RD 150 PLATINUM CATALYST

BAKER'S RD 150 Regenerative Platinum Catalyst is a joint development of Baker & Company, Inc. and Sinclair Research Laboratories. This peak-production catalyst is now used with marked advantage by such companies as Sinclair, Socony and Pure Oil.

REGENERATES IN SITU . . . !

RD 150 provides high initial efficiency plus unique regenerative features. RD 150 assures greater yields at high octane levels, exceptionally long periods of operation, PLUS additional economy made possible by regeneration in situ! We are quite confident that the full story of Baker's RD 150 will be intensely interesting to you.

You can also be relieved by delivery and service problems. Modern Baker plants are geared for large-scale manufacture and refining for recovery of platinum from platinum catalyst.

Upon request, a Baker representative will be glad to consult with you and to furnish detailed information and recommendations.

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... Don't overlook this speedier Power Drive

that takes the work out of pipe threading, cutting, reaming...

RIDGID 400A with wrenchless SPEED CHUCK

Lots of ready power turns pipe, conduit or rod for your hand threaders, cutters, reamers—even up to 12" geared tools with drive shaft. New Speed Chuck opens and closes easily, guaranteed to grip tight forward, reverse; jaws have replaceable insert teeth for longer life. Light, compact, portable—built for years of service. Bench, stand and wheel-stand models. See and try the 400A—at your Supply House!

"Threaded Pipe—*It's Tight—It's Best—Costs Less*"

RIDGID 504 quick-opening threader for power drive use—self-contained dies for 1" to 2" pipe or conduit.

RIDGID Work-Saver Pipe Tools

The Ridge Tool Company • Elyria, Ohio, U.S.A.

Suppliers

Silver to field sales engineer replacing Fox in the Rochester-Niagara Frontier district.

Vitro Corp. of America—Frank B. Jewett, Jr., has been made a vice-president and member of the board of directors. He comes to Vitro from General Mills, Inc., where he has been largely in research and development.

Blaw-Knox Co.—Donald W. Beery to manager of the low temperature and synthetic fuels department, Chemical Plants Division.

Selas Corp. of America—Frank R. Brown to works manager; Ernst A. Siemssen to superintendent of erection.

Clark Bros.—William E. Dobbins to central regional sales manager, coordinating the activities of the Houston, Tulsa and Chicago offices.

Rockwell Mfg. Co.—Thomas O. Carson, formerly manager of distributor sales and assistant product manager of Nordstrom valves, to district sales manager of the Pittsburgh offices. C. B. Goff, Jr., and A. J. Komich to assistant product managers, respectively, of Nordstrom valves and petroleum meters. All are in Rockwell's Meter and Valve Division.

Consolidated Electrodynamics Corp.—Gerald P. Foster to chief, services section, systems division, with responsibility for the division's engineering services and administrative and fiscal planning; John P. Moffat, Jr., to assistant director of quality control; Francis T. Greenup to assistant chief product engineer, while continuing his direct supervision of the engineering design section; David J. Fraade to sales specialist in the field of process control instrumentation.

Beckman Instruments—Lee Cahn, from chief project engineer, to product line supervisor for infrared spectrophotometers; Phil Evans to sales engineer of these instruments; Edwin A. Houser, from instrument and application engineer for Phillips Petroleum Co., to the application engineering staff.

Lunkenheimer Co.—Tollie C. Venable to sales representative with headquarters in Houston.

CDC Control Service—Alfred Krieg to procurement engineer of this firm of automation specialists. He has been with Catalytic Construction Co. and Socony Mobil Oil Co.

(To obtain more data on advertised products see page 142)

ammonia

1,035 tons/day from seven FW plants

This Tonnage capacity is a measure of *experience* that can be a valued asset to prospective ammonia producers anywhere in the world.

Seven modern synthesis plants, completed or under construction by Foster Wheeler — total capacity, 1035 tons of anhydrous ammonia per day!

Foster Wheeler's specialized know-how embraces all phases of process and equipment design, fabrication and erection. For complete information, write for Bulletin 0-54-1. *Foster Wheeler Corporation, 165 Broadway, New York 6, N.Y.*

Designed and engineered by our Paris office, this ammonia plant at Cubatao, Brazil, is being erected by 100 per cent Brazilian labor. It is a typical example of the flexibility and world-wide coverage of Foster Wheeler's engineering and construction services.

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March 26, 1956

To All Refining Members of the Petroleum Industry:

BIENVENUE A MONTREAL AU MOIS DE MAI!

If your French is still a little rusty, don't worry. When you come to Montreal for the mid-year meeting of the A.P.I. Division of Refining, you will find that no matter what language you speak it will certainly be a case of "French without tears," as the saying goes.

In fact, as an article on Montreal in this issue of Petroleum Processing (pp. 70 and 71) tells you, a visit to Montreal has the Gallic charm of a stay in Paris itself.

Your Canadian hosts are looking forward to making this one of the outstanding mid-year meetings in the history of the A.P.I. As the first meeting outside the U.S. in A.P.I. history, it has been a happy international challenge to us. We are planning on visitors having the best possible time, both in and out of sessions.

We won't say anything about the program - because details on it appeared in the March Petroleum Processing - except that it promises to have the breadth and depth to do the best possible job of keeping you up-to-date on the world's most exciting industry.

We won't say anything about the special program for the ladies, except that Montreal is famed for its shops and points of interest.

We won't say anything about unique Montreal as a major petroleum processing centre - already you have read about that, including an article in this magazine just last month - except to invite you to drop around and see those Canadian plants.

We do say that if you have any doubts about coming up next May 14-17, forget them right now. If you can say "Oui, oui!" your French is good enough. Your Canadian committee will look after the rest.

Sincerely,

A. G. Farquharson

A. G. Farquharson, Chairman

AGF:wb

Petroleum Sessions at ACS Meeting

THE Division of Petroleum Chemistry will offer a full program at the Dallas National meeting of the American Chemical Society Apr. 8-13. In addition, other divisions will offer symposia of interest to refiners. Sessions will be held at the Statler Hilton and Dallas Hotels. Papers sponsored by the division are as follows:

"Use of Tracers in Refinery Studies": Part 1—"Catalyst Mixing Patterns in Commercial Catalytic Cracking Units," by E. Singer, D. B. Todd, and V. P. Guinn.

Part 2—"Stack Loss of Catalyst from Commercial Catalytic Cracking Units," by D. B. Todd, and W. B. Wilson.

Part 3—"Gas Mixing Characteristics of a Fluid Bed Regenerator," by A. E. Handlos, R. W. Kunstman, and D. Q. Schissler.

"Commercial Performance of Fluid Cracking Catalysts—A New Technique of Study," by W. B. Wilson, G. M. Good, T. J. Deahl, C. P. Brewer, and W. H. Appleby.

"Measurement of Solids Concentration in Fluidized Systems by Gamma-Ray Absorption," by R. N. Bartholomew and R. M. Casagrande.

"Determination of Micro Amounts of Organic Chloride in Petroleum Products," by C. S. Pennington, W. J. Savournin, and A. L. Juliard.

"The Use of Pressure to Investigate Molecular Interaction in Molecular Structure," by Harry G. Drickamer (Ipatieff Award address).

"Relative Activities of Acidic Solid Catalysts in Cracking and Isomerization Reactions," E. W. Swegler, R. L. Golden, R. M. Lago, C. D. Prater, and P. B. Weisz.

"Measurement of Activity Constants for Cyclohexane Dehydrogenation of Various Solid Catalysts," by Messrs. Lago, Prater and Weisz.

"A Method for Estimating Heat of Reaction in Catalytic Reforming," E. J. Gornowski and G. F. Feldbauer, Jr.

"Characteristics of Houdresid Gasoline," by R. K. Smith, W. E. Schortmann, and G. A. Mills.

"Distribution of Metal Contaminants on Cracking Catalysts," by J. E. McEvoy, T. H. Milliken, and G. A. Mills.

"Catalytic Cracking of Petroleum Residuum," by P. H. Johnson, C. R. Eberline, and R. V. Denton.

"Some Effects of Selected Nitrogen-Containing Compounds on Three Gasolines," by J. F. Brown, S. S. Tihen, and W. I. R. Murphy.

"Pre-Flame Reactions of Blends of Hydrocarbon in a Motored Engine," by E. W. Malmberg, M. L. Smith, W. Lee, G. Myers, and I. Lee.

"Esso Lamp Method for Sulfur in Petroleum Products," by C. C. Hale, E. R. Quiram, J. E. McDaniel, and R. F. Stringer.

"Desulfurization and Refining of Naphthas by Metallic Sodium," by B. M. Vanderbilt.

"The Identification of Thiophene in Virgin Petroleum," by C. J. Thompson, H. J. Coleman, L. Mikkelsen, D. Yee, C. C. Ward, and H. T. Rall.

"Effects on Separation of Changes in Annular Spacing and Packing Density in Packed Thermal Diffusion Columns," by L. J. Sullivan, T. C. Ruppel, and C. B. Willingham.

"Variables in Lamp Design that Affect Smoke Point," by F. W. Rakowsky and R. A. Hunt, Jr.

"Adsorption Analysis of Viscous Aromatic Fractions. The Composition of the Aromatics in a Gulf Coast Lubricating Distillate," by A. E. Hirschler and R. L. James.

"Application of High Molecular Weight Mass Spectrometry to Petroleum Research," by Milburn J. O'Neal, Jr. (Precision Scientific Co. Award in Petroleum Chemistry address).

"Marlex Catalyst Systems," by A. Clark, J. P. Hogan, R. L. Banks, and W. C. Lanning.

"Molecular Structure of Marlex Polymers," by D. C. Smith.

"Properties of Marlex 50 Ethylene Polymers," by R. V. Jones and P. J. Boeke.

"Metal Content of Crude Petroleum," by J. S. Ball, W. J. Wenger, H. J. Hyden, C. A. Horr, and A. T. Meyer.

"Synthesis and Properties of Porphyrin Vanadium Complexes," by J. G. Erdman, V. G. Ramsey, N. W. Kalenda, and W. E. Hanson.

"The Nature of Vanadium in Petroleum": Part 1—"Extraction Studies"; Part 2—"Volatility Studies," by L. K. Beach and J. E. Shewmaker.

"Paper Chromatography of a Petroleum Porphyrin Aggregate," by J. K. Carlton and H. N. Dunning.

"Comparison of Brazilian and Colorado Shale Oils," by G. U. Dinneen, C. S. Allbright, and J. S. Ball.

Here are symposia of particular interest to the petroleum refiner that will also be presented during the meeting:

"Recent Developments in the Use of Ion Exchange Experiments as a Means of Separating Substances."

"Literature of Combustion of Petroleum" (two sessions).

"Corrosion in the Petroleum Industry" (two sessions).

"Plant Management."

"Techniques of Preparing Catalysts in the Laboratory" (four sessions).

"Chemicals from Petroleum" (three sessions).

Rocky Mountain Refiners To Hold Annual, Apr. 26-27

The economics of octane improvement will be a topic discussed at the annual refining committee meeting of the Rocky Mountain Oil & Gas Association. The meeting will be at the Newhouse Hotel, Salt Lake City, April 26 and 27.

On the first day, there will be two speakers on air and water pollution and waste disposal problems. As yet unidentified, the speakers are to be from Standard Oil Co. of California and Standard of Indiana.

T. W. Warren and J. D. Fuller, Ethyl Corp., will give an illustrated talk, "Watch Those Octane Costs," with a review of catalytic reforming. Jet engines and their future development will be examined by Prof. W. P. Barnes of the University of Utah's department of mechanical engineering.

The final talk on April 26 will be given by a person from Utah Oil Refining Co. The speaker will discuss the company's new Ultraformer, and this will be followed by a visit to the new unit, expected to be on stream by that date.

On April 27 there will be a discussion of "Refinery Fires—Basic Causes and Methods of Control" by Oliver W. Johnson, chief fire protection engineer of California Standard.

Two talks on public relations in the refinery will be given by J. H. Herbert, Socony Mobil Oil Co., and Harrison Brewer, Husky Oil Co.

ASLE Meeting-Exhibit in Pittsburgh, Apr. 4-6

Fire resistant fluids and the effect of environmental factors on lubricants are two topics of exceptional interest to be discussed at the American Society of Lubrication Engineers' 11th annual meeting and exhibit. The event will be at the Hotel William Penn, Pittsburgh, April 4 to 6.

Some papers of special interest to petroleum refiners are as follows:

"Surface Viscosity and Elasticity of Lubricating Oils," by D. W. Criddle, California Research Corp.

"Flow Analysis of Lubricants from Measurements with an Automatic Viscometer," by R. N. Weltmann and P. W. Kuhns, NACA.

"Problems in Hydrodynamic Lubrication," by E. K. Gatcombe, U.S. Navy.

"Concentration Effects of Cutting Oil Additives in Performance Evaluation," by A. Dorinson, Sinclair Research Laboratories.

"The Dynamic Demulsibility Characteristics of Oils," by E. W. Brennan and R. G. Moyer, Pure Oil Co.

"Properties of Synthetic Ester Lubricants," by M. Z. Fainman and R. S. Barnes, Standard of Indiana.

"Grease Flow in Shielded Bearing Service," by R. O. O'Halloran, J. J. Kolfenbach, and H. L. Leland, Esso Research and Engineering Co.

"Capillary Viscometry of Lubricating Grease," by L. C. Brunstrum and R. H. Leet, Standard of Indiana.

"High Temperature Lubricant Studies," by E. E. Klaus and M. R. Fenske, Pennsylvania State University.

"Effect of Engine Operation on Synthetic Gas Turbine Lubricants," by T. F. Davidson and J. H. Way, Wright-Patterson Air Force Base.

"Current Research in the Bacteriology of Soluble Oil Emulsions," by H. Pivnick, L.

R. Sabina, R. Samuel-Maharajah, and C. K. Fotopoulis, University of Nebraska.

"Phosphate Base Fluids," by F. H. Langenfeld, Monsanto Chemical Co.

"Aqueous Base Fluids," by W. H. Millett, Carbide & Carbon Chemical Co.

"Emulsions," by R. G. Larson, Shell Oil Co.

Corrosion Short Course At U. of Okla., Apr. 3-5

A session on corrosion control in plants and refineries and another on corrosion instruments will highlight for refiners the short course on corrosion control to be given Apr. 3-5 by the University of Oklahoma, Norman, Okla.

In the discussion of corrosion in plants and refineries, these papers will be read:

"Corrosion Control in Steam and Condensate Systems," by M. C. Forbes, Aquatrol, Inc.

"Cathodic Protection of Underground Plant and Yard Equipment," by Gordon L. Doremus, Cathodic Protection Service.

"Corrosion Control in Recirculating Cooling Water Systems," by Dr. P. G. Bird, Wright Chemical Corp.

"Preventing Stress Corrosion," by R. C. Schueler, Phillips Petroleum Co.

The session on instruments will include these papers:

"Instruments Used in Corrosion Control," by J. R. James, Cathodic Protection Service.

"Inspecting for Corrosion," by Dwight Evans, Engineering Test Services.

"Measurement of Corrosion Damage," by Jim Cowles, consultant on cathodic protection.

Group to Hear What's New In Industrial Controls

A conference to examine new developments in instrumentation for industrial control, the second meeting of this type since 1952, will be held Apr. 26-27 at the Hotel Bradford, Boston, under the sponsorship of three technical societies: the American Institute of Electrical Engineers, American Society of Mechanical Engineers, and Instrument Society of America.

Here are some of the papers to be read at the conference:

"The Human Bottleneck in Data Systems," by Bernard S. Benson, Benson-Lenher Corp.

"The Dynamics of Electronic Self-Balancing Systems," by G. R. Jacob, Brown Instruments Division, Minneapolis-Honeywell Regulator Co.

"Recent Developments in Information Display and Recording": "A New Type Recorder Mechanism," by R. C. Langford, Weston Electrical Instrument Corp.; "A New Concept in Display and Recording," by J. A. Peterson, Radiation, Inc.; "A Novel Character Display Storage Tube," by H. M. Smith, Hughes Aircraft Co.

"Modern Scanning, Monitoring, Display and Circuitry Techniques in Plant Data Systems, " by a representative of Panellit, Inc.

"Analog-to-Digital Conversion: Telemetering Needs and Techniques for Modern Production and Research," by Carl P. Spaulding, G. M. Giannini & Co., Datex Div.

"New Developments and Trends in Analog-Digital Data Systems": "Transducer-Transmitters for Modern Data Systems," by J. V. Werme and W. F. Newbold, Brown Instruments Div., Minneapolis-Honeywell; "A New System for Analog Acquisition and Digital Processing of Data," by William Kneen, Consolidated Electrodynamics Corp.; "New Developments in Radio Telemetry Systems," by George S. Shaw, Radiation, Inc.

"Advanced Data System in the Chemical Industry," by T. M. Vick-Roy, du Pont Co.

Chemical Industry a Topic At AIEE Meeting, Apr. 2-4

Electrical engineering in the chemical industry will be allotted two sessions of the southwest district meeting of the American Institute of Electrical Engineers. The Baker Hotel, Dallas, is the site, and Apr. 2-4 the date of the meeting. The sessions on the chemical industry are scheduled for Apr. 3. Here are the subjects to be discussed:

"Problems of the Utilities Furnishing Power to Chemical Plants."

"Chemical Plants—Considerations in the Use of Purchased Power."

"Expansion of Electrical Facilities in Chemical Plants."

"Overall Aspects of Motor Control in Chemical Plants."

"High Voltage D-C Testing of Cables and Cable Fault Location."

"Corona in Metal-Clad Switchgear."

"Problems and Limitations of Electrical Installations in Class 1, Groups A and B Hazardous Locations."

"Now and Tomorrow."

Oil Man's Calendar

APRIL

American Institute of Electrical Engineers, southwest district No. 7, Dallas, Apr. 2-4.

Corrosion Control Short Course, central Oklahoma section of NACE and University of Oklahoma, University Extension Study Center, Norman, Apr. 3-5.

American Society of Lubrication Engineers, annual, William Penn Hotel, Pittsburgh, Apr. 4-6.

American Chemical Society, national meeting, Dallas, Apr. 8-13.

Natural Gasoline Assn. of America, annual, Texas Hotel, Ft. Worth, Apr. 11-13.

"Economic Practices in the Chemical and Petroleum Industries," Philadelphia-Wilmington Chapter, American Institute of Chemical Engineers, at University of Pennsylvania, Apr. 17.

Southwestern Gas Measurement Short Course, University of Oklahoma, Norman, Apr. 17-19.

National Petroleum Assn., semi-annual, Hotel Cleveland, Cleveland, Apr. 18-20.

World-Oil Exposition, Houston, Apr. 25-29.

Rocky Mountain Oil & Gas Assn., annual meeting, refining committee, Newhouse Hotel, Salt Lake City, Apr. 26-27.

American Institute of Electrical Engineers, 2nd Conference on Recording and Controlling Instruments, Bradford Hotel, Boston, Apr. 26-27.

American Petroleum Institute, Safety and Fire Protection Committee, mid-year meeting, Warwick Hotel, Philadelphia, Apr. 30-May 4.

MAY

Petroleum Industry Electrical Assn., annual, Statler Hilton Hotel, Dallas, May 1-3.

American Institute of Electrical Engineers, northwestern district, Rochester, N. Y., May 2-4.

Liquefied Petroleum Gas Assn., convention and trade show, Conrad Hilton Hotel, Chicago, May 6-9.

American Institute of Chemical Engineers, national meeting, Roosevelt Hotel, New Orleans, May 6-9.

American Welding Society, annual show, Memorial Auditorium, Buffalo, N. Y., May 9-11.

American Petroleum Institute, Refining Division mid-year meeting, Sheraton-Mt. Royal Hotel, Montreal, May 14-17.

11th Purdue Industrial Waste Conference, Purdue University, Lafayette, Ind., May 15-17.

30th Engineering Industries Exposition, New York State Society of Professional Engineers, with annual meeting, Statler Hotel, New York, May 17-19.

Western Petroleum Refiners Assn., regional, Toledo, Ohio, May 24-25.

4th Conference on Mass Spectrometry, ASTM Committee E-14, Netherlands Plaza Hotel, Cincinnati, May 27-June 2.

Chemical Institute of Canada, annual, Mt. Royal Hotel, Montreal, May 28-30.

JUNE

Society of Automotive Engineers, summer, Chalfonte-Haddon Hall, Atlantic City, June 3-8.

National Fire Protection Assn., annual, Statler Hotel, Boston, June 4-8.

American Society of Mechanical Engineers, semi-annual, Statler Hotel, Cleveland, June 17-21.

American Society for Testing Materials, annual, with apparatus exhibit, Chalfonte-Haddon Hall, Atlantic City, June 17-22.

Western Petroleum Refiners Assn., regional technical-industrial relations, Broadview Hotel, Wichita, Kan., June 21-22.

American Institute of Electrical Engineers, summer and Pacific general meetings, San Francisco, June 25-29.

AUGUST

6th International Symposium on Combustion, the Combustion Institute, Yale University, New Haven, Conn., Aug. 19-24.

SEPTEMBER

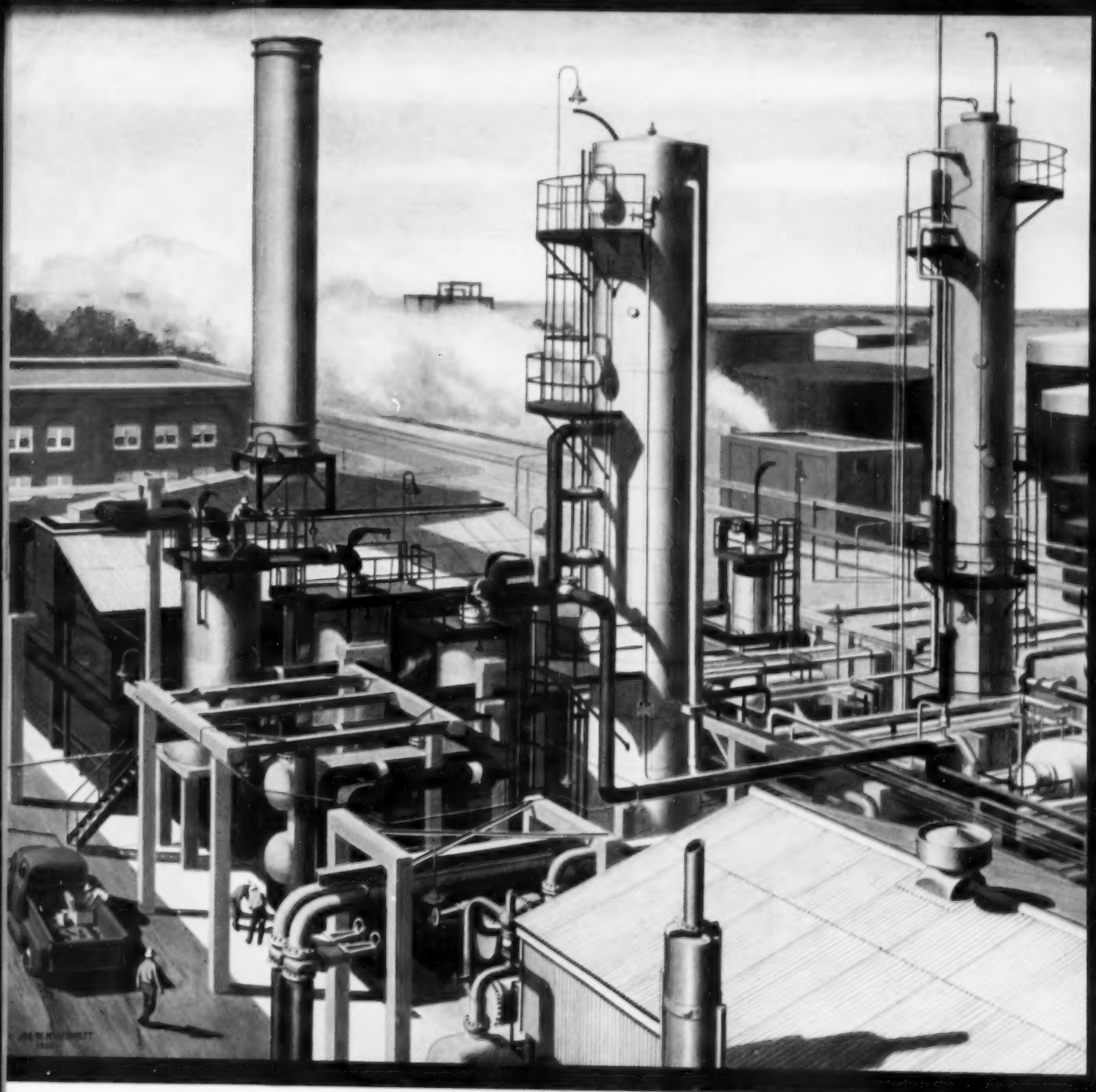
International Congress on Catalysis, Bellevue-Stratford Hotel, Sept. 10-14.

Electrical Conference of the Petroleum Industry, American Institute of Electrical Engineers, Kansas City, Mo., Sept. 12-14.

National Petroleum Assn., annual, Traymore Hotel, Atlantic City, Sept. 12-14.

American Chemical Society, annual, Atlantic City, Sept. 16-21.

Instrument Society of America, annual, Instrument-Automation Conference and Exhibit, New York, Sept. 17-21.



CROWN CENTRAL REFINERY

Crown Central Petroleum Corporation's new Houdriformer at its Pasadena Refinery near Houston, Texas is designed primarily for upgrading naphthas to produce high octane motor gasoline. Further processing makes possible the commercial production of aromatics and aviation blending stocks.

A feature of the Crown Central catalytic reforming unit is a "guard case" to desulphurize and pre-treat charge stocks. This small reactor is an integral part of the Houdriformer unit and strips the stock of contaminants, thereby eliminating the need for complicated pre-treating processes.

A new brochure on the Houdriforming Process is available on request. Write to: Houdry Process Corporation, 1528 Walnut Street, Philadelphia 2, Pa.

HOUDRY

PROCESS CORPORATION

Pioneer in Catalytic Processes

Now... can be your *best* time to cure next winter's heating oil headaches

Some of your next winter's supply of home heating oil may be in your refinery processing run right now.

But how can you be sure it will come out of storage as stable as it goes in? Will *your* distributors be making unprofitable service calls to clean gummed-up ignition systems or replace sludge-clogged filter screens or nozzles?

You can answer these questions *now!* . . . Desired storage stability can be easily obtained by adding Du Pont Fuel Oil Additive No. 2 (FOA-2) to your freshly prepared stocks at the refinery—*before they go into storage.*

Ashless

Many distributors' service calls may be caused by electrical failures due to a metallic ash coating on the electrodes and stack controls. Because it is *ashless,* Du Pont FOA-2 does not contribute to these wasteful calls.

Filter-clogging can be greatly reduced by the addition of FOA-2 because it not only stabilizes the fuel, but also disperses any sludge that may already be formed—by reducing the size of the sludge particles.

Avoid gel-clogged lines

By adding a small amount of Du Pont Metal Deactivator, too, you can protect your heating oil from becoming contaminated by the copper so frequently used in home heating system screens and fuel lines. This protection will, in most cases, eliminate any danger of the fuel lines becoming clogged by a gelatinous material, caused by copper pickup in the line.

Low-cost insurance

You can add both DMD and FOA-2 in amounts sufficient to give your stocks adequate protection all the way through next winter's heating season for only about 1.5¢ per barrel. And you'll find that it more than pays for itself in insurance against future troubles.

Our representatives will be glad to give you test samples and further details about the advantages of these and other Du Pont additives for your petroleum products.

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By Peter J. Gaylor, Patent Attorney, Elizabeth, N. J.

Process Boosts Aromatics Yield During Hydrocarbon Synthesis

SYNTHESIS of hydrocarbons from carbon monoxide and hydrogen, using Fischer-Tropsch or iron-type catalysts is now a fairly well-known way of producing aliphatic hydrocarbons containing a low, if not zero, content of aromatics. According to a recent patent (No. 2,727,055) issued to Standard Oil Co. (Ind.) it is possible, mainly by proper selection of catalyst, to combine CO and hydrogen into liquid products consisting mainly of aromatic hydrocarbons, and particularly of methyl-substituted mononuclear aromatics.

The invention resides in reacting the hydrogen and CO under these conditions: a mol ratio of 1:1, temperature of 800°-925°F., and 30-600 atm. pressure. Furthermore, reaction is in presence of an alumina catalyst having an alkali content of less than 0.3% alkali-metal oxide, by weight of alumina, and preferably less than 0.2 wt.-%. The relative amount of catalyst used can be 100 to 1500 (volumes of gas per volume of catalyst per hour) for fixed bed reactors, or 500 to 1000 for fluidized operation. Alumina of at least 99% purity is required, and trace quantities of Mn, Mo, Sn, W, Fe and Cu may not exceed 1%, although ZnO may be present in somewhat larger quantities. The alumina may be prepared by various methods, such as those disclosed in patents No. 2,432,286, 2,481,824, Re 22,196 or 2,371,237.

In Fig. 1, isotherm A represents the alkali-metal oxide effect at 800°F., and shows that high product yields are obtained at alkali-metal oxide catalyst concentrations of less than 0.15. Isotherm B reflects the product yield obtained at 900°F., and shows that alkali concentrations on the catalysts of less than about 0.10 wt-% provide relatively high yields of liquid aromatic product. The sharp break in the curves at about 0.2% NaO defines clearly the preferable limit of alkali concentration.

Fig. 2 illustrates the effect of temperature upon the yield of aromatics. As can be seen from curve C, which records the behavior of an alumina catalyst containing 0.04% NaO, a maximum yield of aromatic hydrocarbons is obtained at about 900°F. At higher temperatures the yield drops abruptly to less than 6 gm., or about 48 gm. less than the yield at 900°. The curve also shows that, at temperatures as low as about 700°F., even catalyst with this low an alkali concentration is unable to effect any substantial production of aromatics.

Curve D shows that a maximum yield of about 38 gm. is obtained with an alumina catalyst having about 0.1 wt.-% alkali at a lower temperature in the range specified as desired, i.e., 800°F. This yield decreases to substantially zero if the temperature is lowered to 700°, and to 15 gm. if the temperature is raised to 900°F.

Curve E shows that with a catalyst concentration of 0.5 wt.-% of NaO, no operating temperature will provide a yield of aromatics greater than about 10 gm. per cu. meter of CO and hydrogen consumed.

According to curve F, a concentration of 1.4% NaO on the catalyst provides practically no yield of aromatic hydrocarbons within the temperature range employed.

The products made include benzene, toluene, xylenes (trace of ortho), 1—methyl 2—ethylbenzene, mesitylene, durene, etc.

(For more 'Patents,' turn page)

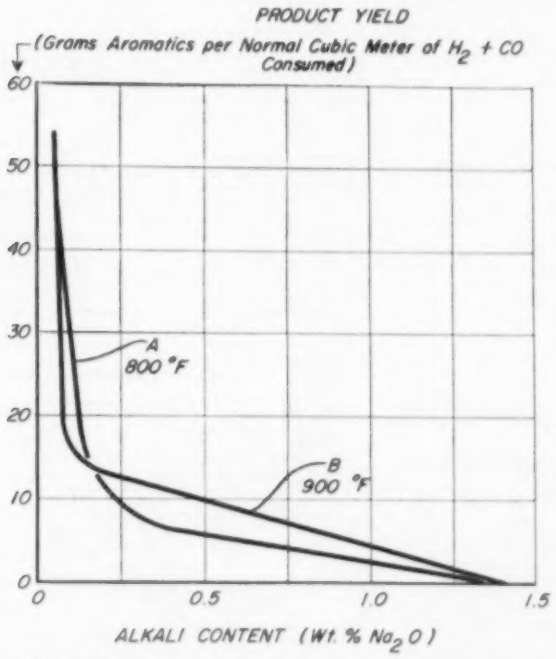

FIG. 1—How concentration of alkali in catalyst affects aromatics yield of product

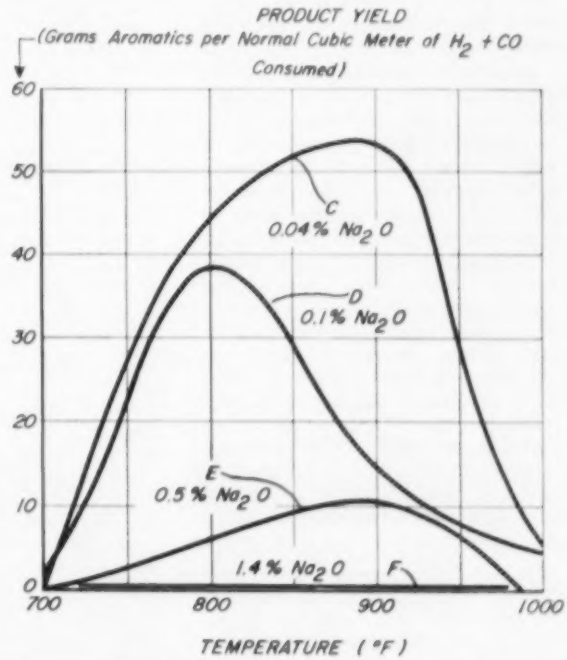

FIG. 2—Effect of temperature on aromatics yield of product with catalyst of four different compositions

Better Heating Oils with Cracked and Virgin Stock

HERETOFORE, heating oil blends consisted of a relatively large proportion of virgin stock as compared to cracked oils. However, owing to the demand for virgin stocks as feed to various cracking operations, such as Fluid catalytic cracking units, the average blends now include an increasing proportion of cracked heating oil fractions, as compared to virgin stocks.

It is well known that heating oils consisting completely or partly of catalytic cracked stocks have an undesirable instability, which causes sediment to form. It is also known that when cracked heating oils are blended with virgin heating oils completely sweetened by oxidation processes (oxidation of mercaptans to disulfides), certain undesirable characteristics are increased because of the incompatibility of components. Such blended fuel oils tend to clog filters, orifices, or conduits of the burning systems in which they are used.

Another well-known fact is that when certain virgin heating oils are blended with cracked heating oils, the carbon residue of the blend often exceeds that of either of the components. This residue is an indication of the extent to which the blended heating oil will carbonize the burners, particularly rotary burners of the wall flame type. To some extent it also determines the burning characteristics and desirability of the fuel.

In order to improve the quality of such blended oils, various processes have been employed. Virgin oils may be caustic washed for sweetening. If they contain a relatively high content of mercaptans, they are normally processed by doctor treating or by an equivalent operation. In many operations, light-cracked heating oils require merely a caustic wash. However, the conventional procedure is to secure the cracked heating oil from a relatively severe cracking operation. In this case it is necessary to acid treat prior to caustic washing to control carbon residue. This latter step is not desirable since acid polymerizes many desirable hydrocarbon components, resulting in loss in yield. Also, the sludge resulting entails expense and handling difficulties.

In U.S. Patent No. 2,717,856, Esso Research & Engineering Co. describes the production of a stable heating oil blend of low Conradson carbon residue (10% residuum) and improved storage stability. The sweetening of the sour virgin fraction (or any combination of sour virgin and cracked components) is carefully controlled by prompt caustic washing of the catalytically cracked component. This is done prior to contact of the cracked stock with air. The virgin fraction also is partially sweetened to a copper number of 15-30, whereupon both stocks are then blended.

Sweetening up to a copper number of 30 sharply reduces the carbon residue. Above this level, though, the gain rapidly falls off, so that the copper number range of 15-30 seems optimum.

Patents Issued Recently

The following classified listing gives the patent number, patentee, or assignee, and a brief description of all patents believed to be of interest to the petroleum processing industries, as contained in the official Gazette of the U.S. Patent Office for Jan. 17, 24, 31, and Feb. 7 and 14, Vol. 702 and 703, No. 3, 4, 5 and 1, 2.

PROCESSES

Refining

2,731,149 (Phillips Petroleum Co.) Continuous adsorption-desorption apparatus.

2,731,391 (L. Sonneborn Sons, Inc.) Cloud point reduction of mineral white oils by treating with adsorbent carrying urea.

2,731,392 (The Texas Co.) Dethiolizing hydrocarbons with glycol ether or amine-caustic regenerable solution.

2,731,393 (Esso Research & Engineering Co.) Desulfurization and sweetening process by treating with alkali carbonate and aldehyde.

2,731,455 (L. Sonneborn Sons, Inc.) Pour point reduction of petroleum oil fractions with activated urea-wax complex.

2,731,456 (Phillips Petroleum Co.) Separation process and apparatus for decomposing crystalline urea adduct.

2,731,457 (British Petroleum Co.) Production and use of a urea suspension in oil for use in formation of adducts.

2,731,810 (Phillips Petroleum Co.) Internal-refrigerant, low temperature fractional distillation method and apparatus.

2,732,328 (Esso Research & Engineering Co.) Two-stage solvent dewaxing of lubricating oil (methyl ethyl ketone-toluol).

2,732,413 (Standard Oil Co.-Ohio) Process for the recovery of benzene by selective clathration, using nickel ammonia cyanide.

2,732,414 (Phillips Petroleum Co.) Process and apparatus for removing hydrates from fractionator overhead product containing hydrocarbons, water and sulfides.

2,733,187 (Esso Research & Engineering Co.) Liquid-liquid treating process for segregating aromatics.

2,733,188. (Esso Research & Engineering Co.) Process for decolorizing and deodorizing petroleum waxes, by adding color and odor inhibitor prior to percolation.

2,733,189 (Gulf Research & Development Co.) Desulfurization of high boiling hydrocarbons, using hydrogen and catalyst.

2,733,190 (British Petroleum Co.) Treatment of sulphur-containing mineral oils with water soluble peroxy compound.

2,733,286 (Esso Research & Engineering Co.) Purification of a benzene fraction by mild liquid phase clay treatment and distillation to remove resultant polymers.

2,733,979 (Universal Oil Products Co.) Method for removing hydrogen sulfide from gaseous streams, using finely divided iron oxide suspended in polyhydric alcohol.

2,734,019 (Esso Research & Engineering Co.) Hydrofining naphthenic lubricating oil, using Co molybdate catalyst on silica-free alumina.

2,734,038 (Sinclair Refining Co.) Process for breaking emulsions formed in the neutralization of acid treated petroleum fractions by partial dehydration and settling.

2,734,049 (Esso Research & Engineering Co.) Urea extraction process following removal of oxygenated organic compounds for concentrating straight-chain olefins.

Conversions

2,731,335 (William W. Odell) Process of treating gasiform fluids at elevated temperatures.

2,731,394 (Esso Research & Engineering Co.) Conversion of heavy hydrocarbon oils in fluidized system.

2,731,395 (Esso Research & Engineering Co.) Conversion of hydrocarbons in two stages with inert and fluidized catalyst particles.

2,731,396 (Esso Research & Engineering Co.) Combination crude distillation and cracking process, including reforming.

2,731,397 (Sinclair Refining Co.) Conversion of hydrocarbon oils with the use of a silica-magnesia cracking catalyst incorporated with a small amount of strontium.

2,731,398 (M. W. Kellogg Co.) Catalytic conversion of hydrocarbons with the stripping of the fouled catalyst particles.

2,731,399 (Sun Oil Co.) Reaction vessel for coke removal.

2,731,400 (Esso Research & Engineering Co.) Conversion of heavy hydrocarbons in fluidized system.

2,731,452 (Standard Oil Co.-Ind.) Group 6a oxide-alkaline earth metal hydride catalyzed polymerization of olefins.

2,731,506 (Esso Research & Engineering Co.) Production of hydrocarbon solvents of low acid wash color by hydroforming naphthenes.

2,731,508 (Esso Research & Engineering Co.) Conversion of heavy hydrocarbons for the production of unsaturates and gasoline with the use of inert solids.

2,732,195 (Svenska Skifferolje Aktiebolaget) Method of treating oil shale deposits with heating elements and recovery of oil and other mineral products therefrom.

2,732,329 (Union Oil Co. of Calif.) Gasoline reforming process employing a nickel sulphate on alumina catalyst.

2,732,330 (Esso Research & Engineering Co.) Conversion of hydrocarbon oils with the use of fluidized solid particles.

2,732,331 (Socony Mobil Oil Co.) Liquid hydrocarbon conversion method and apparatus using moving column of granular contact material.

2,732,332 (Rutgerswerke-A. G.) Coking of bituminous substances in elongated vertical coker.

2,733,191 (Esso Research & Engineering Co.) Simplified oil refinery, using unitary process and fluid catalyst.

2,733,192 (Esso Research & Engineering Co.) Conversion of heavy hydrocarbonaceous materials, involving stem distillation.

2,733,193 (Universal Oil Products Co.) Separating and cracking of oil from oil-bearing sands.

2,733,194 (Sinclair Refining Co.) Method of adding liquid feed to a fluidized coker.

2,733,282 (Esso Research & Engineering Co.) Fluidized solids reactor system.

2,733,283 (Esso Research & Engineering Co.) Process for recovery of aromatics separated from cyclic dienes.

2,733,284 (Esso Research & Engineering Co.) Process for recovery of aromatic hydrocarbons by dimerizing cyclic diolefins, distilling to obtain C_6-C_7 cut, phosphoric acid polymerizing the olefins, and distilling to obtain an aromatic rich fraction.

2,733,285 (Esso Research & Engineering Co.) Recovery of hydrocarbons from highly cracked petroleum fractions by dimerizing the cyclic diolefins, distilling to obtain C_6-C_7 cut, clay polymerizing the olefins and distilling to obtain a benzene rich fraction.

2,733,287 (Lummus Co.) Cracking of hydrocarbon gases and heater therefor.

2,733,993 (Sun Oil Co.) Elevation of granular solids.

2,734,020 (Esso Research & Engineering Co.) Conversion of heavy hydrocarbons in presence of finely divided coke.

2,734,021 (Esso Research & Engineering Co.) Preparation of catalytic feed stocks from heavy hydrocarbons, using finely divided catalyst.

2,734,022 (Esso Research & Engineering Co.) Hydroforming process using group 6 metal oxide on Zn aluminate or alumina gel.

2,734,047 (Esso Research & Engineering Co.) Olefin polymerization with SbS_5 catalyst.

PRODUCTS

Chemicals

2,731,450 (Esso Research & Engineering Co.) Thermosetting tripolymer resins.

2,731,453 (Standard Oil Co.-Ind.) Conversions

If your processing involves:

GRATES or SUSPENDING BEDS
PROTECTIVE ATMOSPHERES
DESSICANTS
MALEIC ANHYDRIDE
SYNTHETIC GAS GENERATION
NITRIC ACID MANUFACTURE
CATALYTIC REFORMING
ETHYLENE OXIDE
PHTHALIC ANHYDRIDE
DEHYDRATION
DEHYDROGENATION

You can benefit by using ALUNDUM* catalyst carriers

More and more chemical engineers are finding in Norton ALUNDUM catalyst carriers the R's they need for faster, better, lower cost production in a wide range of processing.

These fused alumina carriers are characterized by excellent mechanical, thermal and chemical stability. They have high resistance to abrasion and erosion, and their low density is useful for packing and filling applications. Catalytically, they are crystalline in nature and are produced in two surface area types: low and intermediate. Intermediate surface area carriers are subdivided into types A, B, and C, with varying characteristics.

TYPICAL CHEMICAL ANALYSES (%'s)		
	LOW SURFACE AREA	INTERMEDIATE SURFACE AREA
Al_2O_3	89.4-76.6	77.0
SiO_2	9.3-16.8	21.2
Fe_2O_3	0.5 – 1.3	0.2
MgO	0.1 – 0.6	0.4
CaO	0.1 – 0.8	
Na_2O	0.3 – 0.4	0.5
K_2O	0.1 – 1.0	0.2
TiO_2	0.2 – 2.5	0.5

PHYSICAL PROPERTIES						
	Porosity	Water Absorption	Bulk Density	Vol. Bulk Density	Crystal Structure	Surface Area
Low Surface Area	40-50%	20-25%	1.90-2.10 gr/cc	65-80 lbs/ft³	Alpha Alumina	Less than 1m²/gram
Intermediate Surface Area Type A	50-55%	28-30%	1.65-1.70 gr/cc	58 lbs/ft³ (app)	Alpha, Gamma Alumina-chiefly Gamma	60-70m²/gram
Type B	50-55%	28-30%	1.65-1.70 gr/cc	60 lbs/ft³ (app)	Quartz, Alpha, Kappa, Delta Alumina-chiefly Quartz	20-30m²/gram
Type C	50-55%	28-30%	1.65-1.70 gr/cc	62 lbs/ft³ (app)	Alpha Alumina and Mullite	5-10m²/gram

Shapes and Sizes

Spheres: (Low surface area) 3/16"-1" diam; (Intermediate surface area) 1/4"-1/2" diam. *Pellets:* (All carriers) 1/8" x 1/8"-1/2" x 1/2". *Rings:* (All carriers) 1/8" x 1/4" x 3/8" O.D.-1" x 1 1/2" x 1 1/2" O.D.

Typical Applications

Low Surface Area Carriers: phthalic anhydride, maleic anhydride, ethylene oxide, protective atmospheres, synthetic gas generation, grates or suspending beds for active catalysts.

Intermediate Surface Area Carriers: catalytic reforming, dehydrogenation, dehydration, sulfuric acid manufacture, nitric acid manufacture, dessicants.

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(To obtain more data on advertised products see page 142)

of ethylene and propylene to solid polymers with group 6a metal oxides and complex metal aluminum hydride catalysts.
2,731,454 (Phillips Petroleum Co.) Polymeric boric anhydride resinous reaction products.
2,731,458 (Socony Mobil Oil Co., Inc.) Alkylation of yellow phosphorus with olefins.
2,731,468 (Phillips Petroleum Co.) Separation of alkenylpyridines from alkypyridines.
2,731,475 (Phillips Petroleum Co.) Method of producing lactones.
2,731,491 (Gulf Research & Development Co.) Condensation product of naphthenic acids and phenols and methods of making same.
2,731,501 (Gulf Research & Development Co.) Purification of hydroformylation reaction products by reacting olefin, hydrogen and CO.
2,731,502 (Shell Development Co.) Hydroxylation process by peroxide treatment of olefins.
2,731,503 (Esso Research & Engineering Co.) Octyl alcohol synthesis process.
2,731,504 (Badische Anilin- & Soda-Fabrik A. G.) Production of aliphatic alcohols from olefins.
2,731,507 (Eastman Kodak Co.) Recovery of acetylene from gas mixtures with ethylene.
2,732,354 (B. F. Goodrich Co.) Chlorine derivatives of isoolefin-polyolefin polymers.
2,732,376 (Phillips Petroleum Co.) Production of alkenylpyridines.
2,732,377 (Phillips Petroleum Co.) Stabilization of polymerizable heterocyclic nitrogen compounds.
2,732,408 (California Research Corp.) Process for making tertiary-octylphenol.
2,732,412 (Esso Research & Engineering Co.) Accelerating sodium polymerizations.
2,733,207 (Socony Mobil Oil Co., Inc.) Phosphorus and sulfur containing antioxidant.
2,733,227 (Esso Research & Engineering Co.) Reaction product of olefin-diolefin resin with a coumarone-indene resin.
2,733,248 (Shell Development Co.) Polyhalo epoxy methane naphthalene compounds.
2,733,249 (Universal Oil Products Co.) Production of polyalkylstilbene quinones and polyalkoxystilbene quinones.
2,733,266 (Union Oil Co. of Calif.) Preparation of isophthalic and terephthalic acids.
2,733,267 (Esso Research & Engineering Co.) Synthetic drying oils.
2,733,279 (Esso Research & Engineering Co.) Process for recovery and purification of cyclodienes from cracked petroleum.
2,733,280 (Esso Research & Engineering Co.) Recovery of cyclo and methylcyclopentadiene.
2,734,046 (Esso Research & Engineering Co.) Process for preparing petroleum resins.
2,734,067 (Allied Chemical & Dye Corp.) Hydrocarbon oxidation in liquid phase with gaseous oxygen while maintaining fixed CO_2.
2,734,078 (California Research Corp.) Hydrolysis of amides.
2,734,079 (California Research Corp.) Process of producing phthalic acids.
2,734,080 (California Research Corp.) Recovery of phthalic acids.
2,734,085 (California Research Corp.) Removal of salts from acetone-phenol mixtures.
2,734,086 (Shell Development Co.) Production of aromatic hydroperoxides.
2,734,088 (The Texas Co.) Monomeric condensation products of alkylated phenols with carbonyl-containing compounds.
2,734,089 (Esso Research & Engineering Co.) Infrared control method for alcohol synthesis.
2,734,092-3 (Sun Oil Co.) Isomerization of cis-decalin to trans, using HF.

Catalysts

2,731,541 (Oxy-Catalyst, Inc.) Catalytic structure comprising electrical resistance element having thin film of oxide.
2,732,349 (Esso Research & Engineering Co.) Method of preparing hydro-forming catalysts containing Pt or Pd.
2,733,205 (Du Pont Co.) Process for abstracting anions from alumina sol.
2,733,219 (Universal Oil Products Co.) Preparation of alumina-aluminum halide catalysts.
2,733,220 (Universal Oil Products Co.) Manufacture of spherical gel particles.

Fuels

2,731,802 (Phillips Petroleum Co.) Automatic shut-off valve in liquefied gas system.
2,731,803 (Phillips Petroleum Co.) Hydraulic control system for liquefied gas flow control.

Lubricants

2,731,415 (American Cyanamid Co.) Tall oil pitch-phosphorus sulfide reaction product and metallic salts as dispersants for lubricants.
2,731,416 (Gulf Research & Development Co.) Naphthenic acid-phenol compounds, methods of making same, and lubricants containing them.
2,731,417 (Esso Research & Engineering Co.) Water resistant soda base grease.
2,731,418 (Esso Research & Engineering Co.) Hydraulic transmission fluid of high detergency and anti-friction properties.
2,732,285 (Esso Research & Engineering Co.) Method for determining the deposit-forming tendencies of oils by heating with unsaturated ketone to produce synthetic sludge.
2,732,345 (Shell Development Co.) Soluble oils (one phase), containing oil insoluble nitrite and diol-ketol solubilizer.
2,732,346 (Esso Research & Engineering Co.) Sulfurized hydrocarbon lubricant additive.
2,732,348 (Shell Development Co.) Oil-in-water metalworking emulsion lubricant.
2,733,208 (Esso Research & Engineering Co.) Mixed alkaline earth metal soap grease.
2,733,209 (Esso Research & Engineering Co.) Magnesium-lithium-sodium grease composition.
2,733,210 (Du Pont Co.) Lubricant compositions and method of making same (aq. sdn.).
2,733,235 (Esso Research & Engineering Co.) Mineral oil additive (P-S compound).
2,734,030 (Esso Research & Engineering Co.) Mixed soap-complex grease compositions.
2,734,031 (Hooker Electrochemical Co.) Lubricants containing polymers of cyclopentadiene.
2,734,032 (Sun Oil Co.) Lubricants containing alkyl phenol antioxidant with some organic oxide.

Specialties

2,731,324 (Sinclair Refining Co.) Vapor phase corrosion inhibitor containing alkanoyloxyacetic acid and method of using same.
2,731,328 (Phillips Petroleum Co.) Carbon black manufacture.
2,732,356 (Esso Research & Engineering Co.) Tacky oil composition for air filters containing lithium soap and polyisobutylene.
2,733,159 (Anderson-Prichard Oil Corp.) Bituminous emulsion for spray atomization.
2,733,225 (Fibreboard Products, Inc.) Modified paraffin wax grease-resistant coating composition and paperboard coated therewith.

Miscellaneous

2,731,486 (Ruhrchemie A. G.) Catalytic hydrogenation of carbon monoxide to produce low molecular weight hydrocarbons.

EQUIPMENT

Instruments

2,732,715 (Robert E. Hawkins) Liquid level gage.
2,732,716 (Bristol Co.) Vapor pressure thermometer.
2,733,594 (Illinois Testing Laboratories, Inc.) Dew-point detecting device.
2,733,602 (Standard Oil Co.—Ohio) Isothermal calorimeter.
2,733,604 (Wallace H. Coulter) Electromagnetic flowmeter.
2,733,606 (Joseph Lucas Ltd.) Liquid flow rate meters.

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This position will require extensive experience with very complex fluid flow problems, such as are encountered in the following types of equipment: distillation, dust collecting, filtration, grinding, drying, materials handling, absorption-extraction, and agitation and mixing. Successful applicant will develop specialized equipment such as jet reactors, jet compressors, jet absorbers, and pipe line reactors, and provide technical advice on fluid flow problems involved in handling slurries, plastics, highly viscous polymers, dispersion, and semi-solids.

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Successful applicant will have had extensive experience in the installation, application, and maintenance of chemical process instrumentation. Duties include: setting up or modernizing plant maintenance forces for proper care of electronic, pneumatic, and hydraulic controls and instrumentation; making cost studies; planning and organizing training programs for maintenance personnel; instituting effective preventive maintenance programs; development of standard procedures for instrument calibration and maintenance; and assistance in establishing efficient installation methods and in start-up of new facilities.

HEAT TRANSFER

Duties include: trouble-shooting on equipment, such as pipe line reactors, fluidized solids reactors, and film driers, where heat transfer is one controlling factor; selection of equipment, such as heat exchangers, evaporators, furnaces, and driers; evaluation of equipment to determine optimum alternatives; and theoretical analysis of problems in heat transfer in proposed equipment for new applications. Other typical heat transfer problems encountered involve reboilers, inert gas generators, direct fired production furnaces, and indirect fired retorts.

PUMPS AND FLUID MECHANICS

Desired qualifications will include extensive engineering knowledge of and familiarity with equipment used in the fluid mechanics field. Development, research, design, maintenance, or teaching experience with pumps, compressors, jets, and seals is desirable. Responsibilities of the position will involve selection of equipment, trouble-shooting, and consultation on fluid flow and mechanical design aspects of piping, pumps, jets, compressors, and seals. Duties include evaluation of available equipment and recommendations for equipment modification for special applications.

AUTOMATIC PROCESS CONTROL

Position requires broad and detailed experience in research, application, consulting, or design of automatic controls for chemical, mechanical, or aeronautical applications. The successful applicant will provide consulting advice to operating plants and development laboratories on the application of automatic control to new processes and for the improvement of existing processes. Position will require the study of process controllability by analysis of open and closed loops and the measurement of control characteristics of instrument components.

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Successful applicant will analyze existing and proposed chemical processes for utilization of petroleum processing equipment and methods for obtaining greater yield and lower equipment investment, particularly with respect to hydrocarbon processes. Typical operations to be evaluated include solid fluidization, adsorption, reforming, and catalysis. This requires broad familiarity with equipment such as hypersorbers, distillation columns, cracking furnaces, low temperature refrigeration systems, and compressors. Other duties include trouble-shooting and economic evaluation of alternative processes and equipment.

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Patents

2,734,136 (Instruments, Inc.) Level indicator.
2,734,377 (Socony Mobil Oil Co.) Apparatus for detecting contamination of a liquid.
2,734,380 (Erdco Engineering Corp.) Magnetic flowmeter.

Processing, general

2,731,241 (Joseph D. Christian) Heat exchange device.
2,731,466 (Phillips Petroleum Co.) Quench section for carbon black production furnace.
2,732,076 (Rema V. Kuehn) Juice extractor.
2,732,086 (Auxilius P. Schnyder) Apparatus for feeding solids into pressure vehicles.
2,732,944 (Clyde C. Hays) Sludge removing means.
2,732,947 (Esso Research & Engineering Co.) Gravity filter.
2,733,054 (Koppers Co.) Spray-type gas and liquid scrubber.
2,733,055 (Fred Ophuls and Walter E. Bernd) Cooling tower.
2,733,056 (Kerag Kesselschmiede, Apparate und Maschinenbau) mixing of gases and liquids.
2,733,692 (Foster Wheeler Corp.) Oil heater.
2,733,693 (Svenska Oljeslageri Aktiebolaget) Method for preventing sediment formation and the like.
2,733,762 (University of Minnesota) Spray drier.
2,734,592 (Universal Oil Products Co.) Gas separator.
2,734,593 (Graver Tank & Mfg. Co.) Demulsifying apparatus.
2,734,805 (Houdry Process Corp.) Gas contacting and disengaging apparatus.
2,734,824 (Great Northern Paper Co.) Closure for pressure tanks.

Pumps & Compressors

2,730,951 (U.S. Atomic Energy Commission) Electromagnetic centrifugal pump.
2,730,952 (Edwin J. Whiffen) Variable capacity pump.
2,731,920 (Scognamillo Engineering Co.) Rotary pump.
2,732,802 (Eaton Mfg. Co.) Internal gear pump.
2,732,805 (Societe d'Inventions Aeronautiques et Mecaniques S.I.A.M.) Self-regulating feed pump.
2,732,806 (Enrique Clapes Massons) Electromagnetically operated pump for raising liquids.
2,732,807 (U.S. Atomic Energy Commission) Diaphragm pump.
2,733,660 (Worthington Corp.) Automatic variable speed control mechanism for fluid pumps.
2,733,664 (Milton Roy Co.) Pump with facilities for cleaning.
2,733,666 (Denison Engineering Co.) Axial piston pumps.
2,734,679 (Edwards High Vacuum Ltd.) Vapor vacuum pumps.

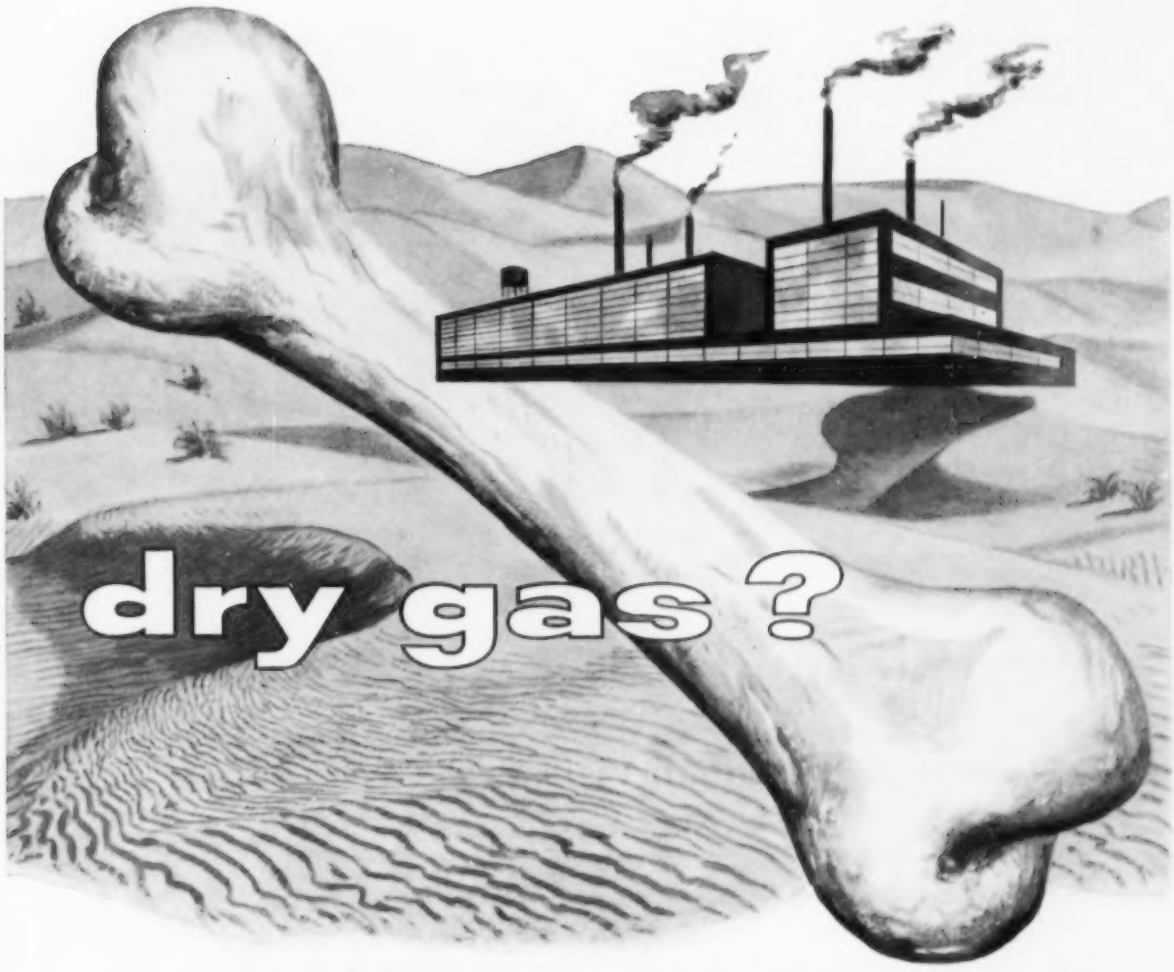
Valves & Fittings

2,731,030 (Petroleum Systems, Inc.) Overflow float valves.
2,731,207 (Mueller Co.) Relief valve.
2,731,231 (John C. Garrott) Resilient seal valve.
2,732,170 (Saunders Valve Co. Ltd.) Gate valve.
2,732,172 (Hammel-Dahl Co.) Valve.
2,732,852 (Borg-Warner Corp.) Control valve.
2,732,853 (G. Kromschroder A. G.) Pressure relief device.
2,732,854 (Robert H. George) Drain valves.
2,732,855 (James Clarence Hobbs) Valve.
2,732,856 (Shand and Jurs Co.) Vacuum vent valve.
2,732,857 (Shand and Jurs Co.) Fluid pressure sealed diaphragm relief valve.
2,732,858 (Thompson Products, Inc.) Flow controlling apparatus.
2,732,859 (Dole Valve Co.) Fluid mixing device.
2,732,898 (Wales-Strippit Corp.) Compressible liquid stripping unit.
2,733,041 (Esso Research and Engineering Co.) Steam valve.
2,733,729 (Ralph W. Wolfe) Pressure-responsive, self-closing safety valve.
2,733,732 (Borg-Warner Corp.) Valve control mechanism.
2,733,865 (A P Controls Corp.) Temperature compensated by-pass valve.
2,734,526 (American Cyanamid Co.) Fluid pressure control.
2,734,527 (Walter S. Baer, Sr.) Constant pressure control valve.
2,734,714 (Hydril Corp.) Valve.
2,734,715 (Hydril Corp.) Spherical valve.

Miscellaneous

2,731,233 (William R. Lindsay) Pipe puller.
2,731,334 (Chicago Bridge & Iron Co.) Vapor storage vessel and method of making same.
2,732,873 (Kenneth L. Treiber) Pressure indicating closure seal for liquid-receiving containers.

(To obtain more data on advertised products see page 142)



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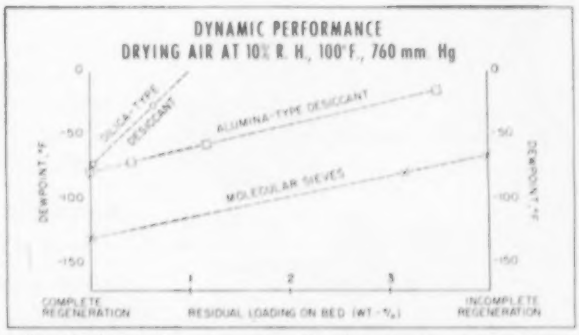

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Thermodynamics for the Millions?

Principles of Chemical Engineering Thermodynamics, by Ernest D. Wilson and Harold S. Ries, 1956, 6½ x 9¼ in., 376 pp., indexed, illustrated, hard cloth cover, $7.50, McGraw-Hill Book Co., Inc., 330 West 42nd St., New York 36, N. Y.

THE authors of this book have expressed a prime goal of making the discussion of chemical engineering thermodynamics simple and easily understood. As evidence of their success, one of the early reviewers of the book—before it reached publication—considered it to have "excessive simplicity." While trying for simplicity, however, the authors have tried not to sacrifice accuracy or omit important subjects.

One example of the "simple" approach was to drop the classical pure logic (or abstract reasoning) approach in the introduction of the second law of thermodynamics, since few engineering students have the training needed to handle the tools of "pure logic" as applied to thermodynamics.

In order to take the subject of thermodynamics out of the clouds, the authors try to show the student where this subject can be of use to him. Therefore, thermodynamics is here presented as a tool and a method for solving industrial problems such as might actually be met in industry.

Careful presentation of subject material based on a total of 18 years teaching experience between the two authors, makes this book of equal value to the undergraduate student, or the person wishing to review his thermo.

How to Find and Identify Petroleum Acids and Bases

The Petroleum Acids and Bases, by H. L. Lochte and E. R. Littmann, 1955, 5¾ x 8¾ in., 368 pp., indexed, illustrated, hard cloth cover, $9.00, The Chemical Publishing Co., Inc., 212 Fifth Ave., New York 10, N. Y.

Though primarily concerned with the general problem of composition and laboratory isolation of petroleum acids and bases, *The Petroleum Acids and Bases* also contains some studies on acids and bases in specific crudes.

In the section on acids, those containing sulfur are not discussed as, with the exception of mercaptans, most of them "are produced during refining with sulfuric acid and so should be classified with the petrochemicals." Acids which are discussed in this book include simple aliphatic acids, naphthenic acids, aromatic acids, and a little on phenols.

The second and shorter portion of the book discusses the many nitrogen containing basic and non-basic compounds found in both straight-run and cracked stocks.

Both the acid and the base sections have brief discussions on the origins of these compounds and their industrial uses.

"Tricks of the Trade" for Distillation Practices

Distillation in Practice, edited by Charles H. Nielsen, 1956, 5x8 in., 133 pp., no index or table of contents, illustrated, $3.00, Reinhold Publishing Corp., 430 Park Ave., New York 22, N. Y.

There is no teacher like practical experience—hence this second book in a series designed to bring practical experience from men in industry to younger chemical engineers.

The first book in the series, *Chemical Engineering in Practice*, was the result of a one-day 1953 meeting of the Philadelphia-Wilmington Section of the American Institute of Chemical Engineers in collaboration with the Dept. of Chemical Engineering, Univ. of Penna. The interest in this meeting was so great that the 8 papers were published in book form by Reinhold.

In 1954, a similar meeting was held by the Philadelphia-Wilmington Section, and the resulting papers were collected to form the present book, *Distillation in Practice*.

Subjects covered include: over-all tower design from a process viewpoint, physical design features of plate columns, some techniques in petroleum fractionation, distillation control, operation of distillation equipment and some commercial aspects of vacuum distillation.

Recent Books Briefly Noted

Hydrogen Peroxide, ACS Monograph No. 128, 1955, by W. C. Schumb, C. N. Satterfield and R. L. Wentworth, 9¼x6¼ in., 759 pp., indexed, illustrated, stiff cloth cover, $16.50, Reinhold Publishing Corp., 430 Park Ave., New York 22, N. Y.

. . . describes the manufacture, properties, technology and uses of hydrogen peroxide.

Instrument Engineering, Vol. III—Applications of the Instrument Engineering Method: Part I—Measuring Systems, 1955, by C. S. Draper, W. McKay and S. Lees, 9x11 in., 879 pp., indexed, illustrated, stiff cloth cover, $17.50, McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York 36, N. Y.

. . . presents a generalized method of attack on the problems of measurement and control for both students and the practicing engineer.

Plastics for Corrosion-Resistant Applications, 1955, by R. B. Seymour and R. H. Steiner, 6x9 in., 423 pp., indexed, illustrated, stiff cloth cover, $7.50, Reinhold Publishing Corp., 430 Park Ave., New York 22, N. Y.

. . . supplies background information needed to select the proper plastic for construction in corrosive atmospheres.

Chemical Processing and Equipment, 1955, United States Atomic Energy Commission, 8x10½ in., 302 pp., table of contents, illustrated, stiff cloth cover, $6.00, McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York 36, N. Y.

. . . to help determine costs in handling special materials. The first part deals with the chemical processing of irradiated fuel elements and the second part with handling of irradiated materials in lab operations.

Instruments for Measurement and Control, 1955, by Werner G. Holzbock, 6x9 in., 371 pp., indexed, illustrated, stiff cloth cover, $10.00, Reinhold Publishing Corp., 430 Park Ave., New York 22, N. Y.

. . . uses non-mathematical language to describe and illustrate the most recent devices for measuring and controlling temperature, moisture, pressure, flow, uniformity, etc.

1954 Vacuum Symposium Transactions, 1955, 8¼x11¼ in., 147 pp., table of contents, illustrated, stiff cloth cover, $10.00, Committee on Vacuum Techniques, Inc., Box 1282, Boston 9, Mass.

. . . abstracts of 34 papers presented in June 1954 symposium held at Asbury Park, N. J.

Crude-Oil Tank Measurement and Calibration—Standard 2501, 1955, available in 8x10½ in. size for 3-hole loose-leaf folders or in 3¼x6¾ Lefax size, 36 and 88 pages respectively, $1.00, American Petroleum Institute, 50 W. 50th St., New York 20, N. Y.

. . . contains material related only to crude-oil tank measurement and calibration (vertical tanks).

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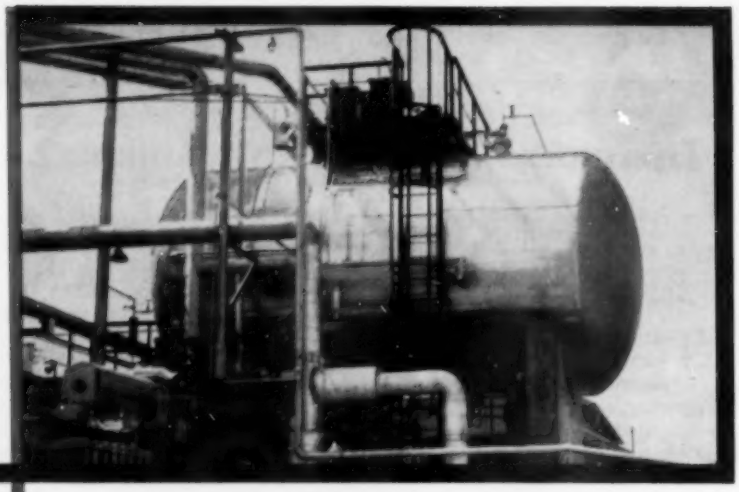

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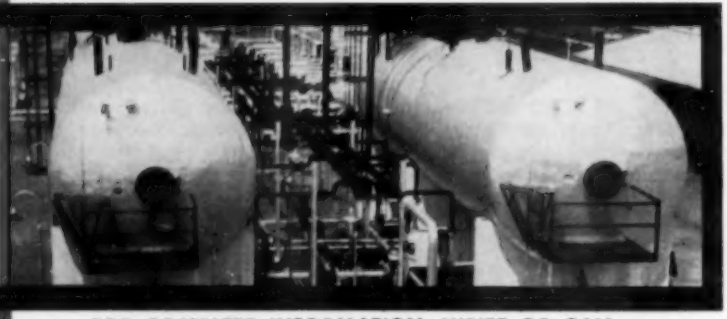

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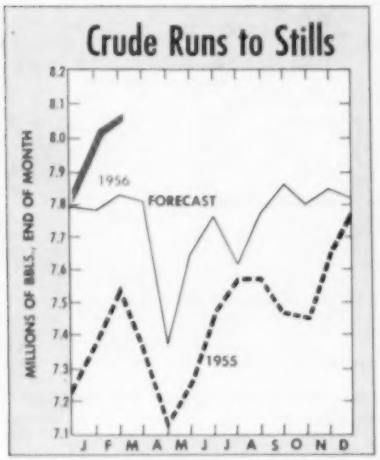
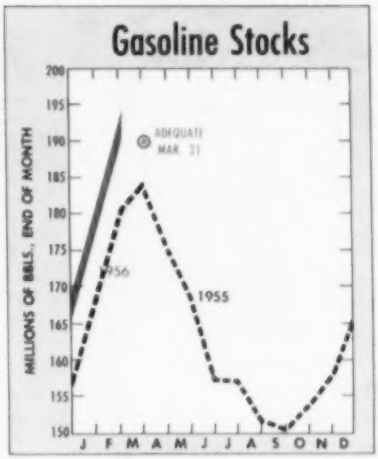
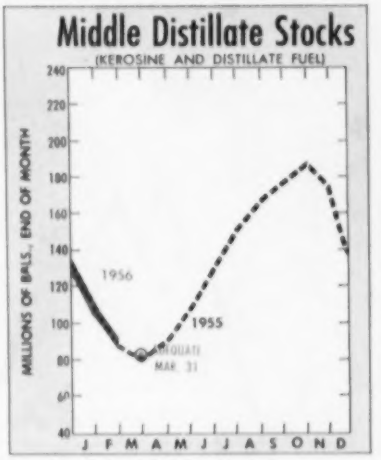





Middle Distillate Stocks
(KEROSINE AND DISTILLATE FUEL)
MILLIONS OF BBLS., END OF MONTH
1956
1955
ADEQUATE MAR. 31
J F M A M J J A S O N D

Product Stocks Reflect High Runs

THE continuing high rate of plant operations, with the emphasis on gasoline output, is pushing gasoline inventories at refineries to a record volume, even with a heavy withdrawal season just ahead. Middle distillate stocks will end the heating season a few thousand barrels higher than a year ago, but not yet too burdensome for the start of the summer buildup of these products against the needs of next fall.

The product stocks at refineries (gasoline, kerosine, distillate fuel oil and residuals) Mar. 2, were 3% larger than on Mar. 4, 1955. Excluding the relatively small volume of residual fuel stocks, product inventories on that date were 6% larger than a year ago.

Crude runs during Jan. and Feb. were nearly 8% larger than a year ago, while total product demand was around 5% greater, about in line with forecasts of first quarter demand. Runs for the first two months were about 3% greater than the volume forecast as adequate for this period. Normally, runs should drop materially in March or early April, as refiners adjust operations from meeting heating oil demand to preparing for the summer motor gasoline business.

OUTLOOK: for heavy shipments of gasoline from refineries in late spring in preparation for a record summer touring season.

Gasoline inventories Mar. 2 were 194,668,000 bbls., already above the level estimated adequate on Mar. 31 for balancing supply-demand. They will be further increased the next few weeks unless crude runs are cut. Stocks Mar. 2 were 6.8% larger than the year before. At the rate of indicated current and also forecast demand, in terms of days' supply, gasoline stocks, however, are about the same as a year ago—51 days' supply.

Lower shipments of heating oil from refineries is reflected in the dropping off of demand for middle distillates from a high figure in January. Middle distillate stocks Mar. 2, (90,189,000 bbls.) were 5,384,000 bbls. higher than on Mar. 4, 1955. They were then at the level forecast as adequate by Mar. 31. However, they may be further reduced before that date.

FEBRUARY KEY STATISTICS

(Figures given in terms of millions of b/d, monthly averages, except stocks, which are in millions of bbls. at end of month)

	Feb. 1956	Jan. 1956	Feb. 1955
CRUDE OIL			
U. S. Production	7.114	7.028	6.835
Imports	.816	.785	.751
U. S. Stocks	255.962	258.322	258.630
Runs to Stills	8.045	8.003	7.549
GASOLINE			
Refinery Output	3.726	3.810	3.567
Refinery Demand	3.374	3.418	3.242
Primary Stocks	194.473	181.067	181.643
MIDDLE DISTILLATES			
Refinery Output	2.319	2.297	2.221
Refinery Demand	2.877	3.331	3.037
Primary Stocks	90.099	107.233	87.574
RESIDUALS			
Refinery Output	1.285	1.299	1.239
Imports	.508	.510	.581
Total Supply	1.793	1.809	1.820
Refinery Demand	1.847	1.853	1.956
Primary Stocks	36.907	38.475	46.042

PRODUCT AND CRUDE PRICES

(Products—¢ gal., weighted average prices in principal refinery markets
Crudes—$/bbl., principal fields
Source—Platt's Oilgram Price Service)

	Feb. 1956	Jan. 1956	Feb. 1955
Gasoline (regular)	11.70	11.81	11.21
Distillate Fuel Oil	9.53	9.41	9.32
Kerosine	10.98	10.85	10.69
Residuals	5.14	5.09	4.22
Above 4 Products	9.37	9.39	8.80
Lube Oils	21.99	21.03	16.58
Crude	2.83	2.83	2.82

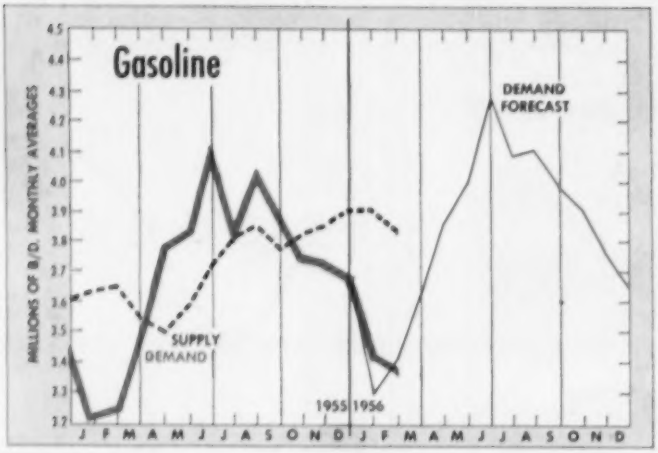
REFINERY YIELDS

% on Crude Runs to Stills

	Feb. 1956	Jan. 1956	Feb. 1955
Gasoline	42.1	43.4	42.3
Kerosine	4.7	4.6	4.9
Distillate	24.1	24.1	24.2
Residuals	16.0	16.2	16.2

SOURCE OF DATA (except prices): Jan. and Feb., API weekly reports; earlier months, Bureau of Mines

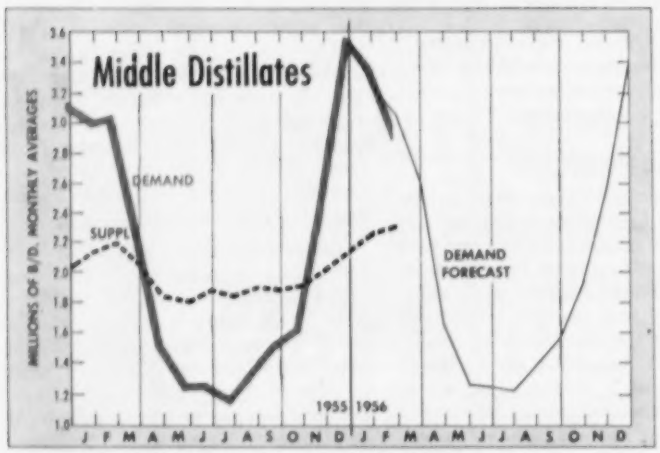
Gasoline Supply Stays Well Above Last Year



MOTOR FUELS

	From Crude	From Nat. Gas	Total
SUPPLY (Millions of b/d)			
Feb. '56	3.391	.445	3.836
Feb. '55	3.229	.426	3.655
Change	+ .162	+ .019	+ .181
% Change	+ 5.0	+ 4.5	+ 5.0
DEMAND (including Exports) (Millions of b/d)			
Feb. '56			3.374
Feb. '55			3.242
Change			+ .132
% Change			+ 4.1
TOTAL SUPPLY (Millions of bbls.)			
2 Mos. '56	205.909	26.545	232.454
2 Mos. '55	189.843	25.307	215.150
Change	+ 16.066	+ 1.238	+ 17.304
% Change	+ 8.5	+ 4.9	+ 8.0
TOTAL DEMAND (including Exports) (Millions of bbls.)			
2 Mos. '56			203.804
2 Mos. '55			189.747
Change			+ 14.057
% Change			+ 7.4

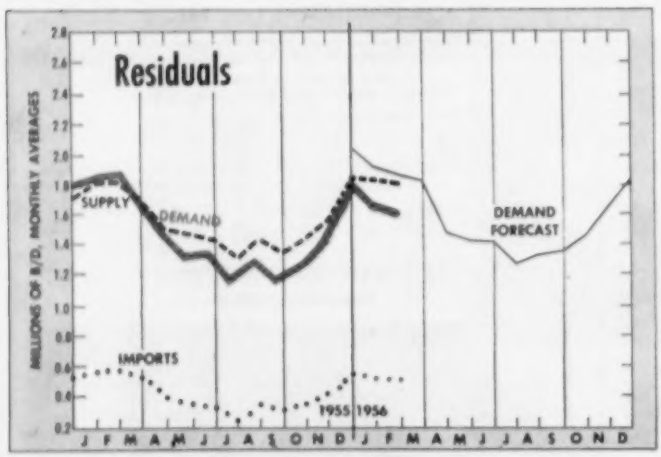
Early Drop Indicated in Distillate Demand


Middle Distillates
DEMAND
SUPPL
DEMAND FORECAST
1955 1956
MILLIONS OF B/D. MONTHLY AVERAGES
J F M A M J J A S O N D J F M A M J J A S O N D

MIDDLE DISTILLATES

	Kerosine	Dist. Fuel Oil	Total
PRODUCTION (Millions of b/d)			
Feb. '56	.380	1.939	2.319
Feb. '55	.374	1.847	2.221
Change	+.006	+ .092	+ .098
% Change	+ 1.6	+ 5.0	+ 4.4
DEMAND (including Exports) (Millions of b/d)			
Feb. '56	.460	2.419	2.879
Feb. '55	.552	2.485	3.037
Change	—.092	— .066	— .158
% Change	—16.7	— 2.7	— 5.2
TOTAL PRODUCTION (Millions of bbls.)			
2 Mos. '56	22.498	115.964	138.462
2 Mos. '55	23.136	105.645	128.781
Change	— .638	+ 10.319	+ 9.681
% Change	— 2.8	+ 9.8	+ 7.5
TOTAL DEMAND (including Exports) (Millions of bbls.)			
2 Mos. '56	31.196	155.556	186.752
2 Mos. '55	32.671	145.345	178.016
Change	— 1.475	+ 10.211	+ 8.736
% Change	— 4.5	+ 7.0	+ 4.9

Residual Shipments Lower than in 1955


Residuals
SUPPLY
DEMAND
DEMAND FORECAST
IMPORTS
1955 1956
MILLIONS OF B/D. MONTHLY AVERAGES
J F M A M J J A S O N D J F M A M J J A S O N D

RESIDUAL FUELS

	Refinery Output	Imports	Total
SUPPLY (Millions of b/d)			
Feb. '56	1.285	.508	1.793
Feb. '55	1.239	.581	1.820
Change	+ .046	— .073	— .027
% Change	+ 3.7	— 12.6	— 1.5
DEMAND (including Exports) (Millions of b/d)			
Feb. '56			1.847
Feb. '55			1.956
Change			— .109
% Change			— 5.6
TOTAL SUPPLY (Millions of bbls.)			
2 Mos. '56	77.554	30.538	108.092
2 Mos. '55	72.959	34.038	106.997
Change	+ 4.595	— 3.500	+ 1.095
% Change	+ 6.3	— 10.3	+ 1.0
TOTAL DEMAND (including Exports) (Millions of bbls.)			
2 Mos. '56			111.006
2 Mos. '55			113.903
Change			— 2.897
% Change			— 2.5

SOURCE OF DATA: Jan. and Feb., API weekly reports; earlier months, Bureau of Mines

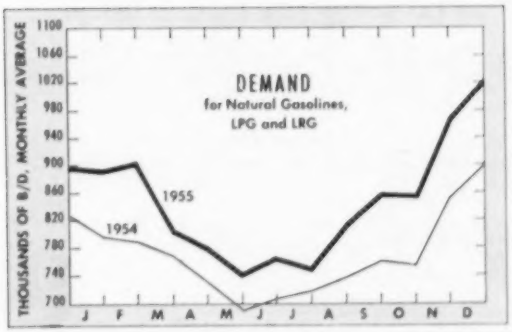
RUNS TO STILLS AND DISTRIBUTION OF PRIMARY STOCKS BY U. S. REFINERY DISTRICTS

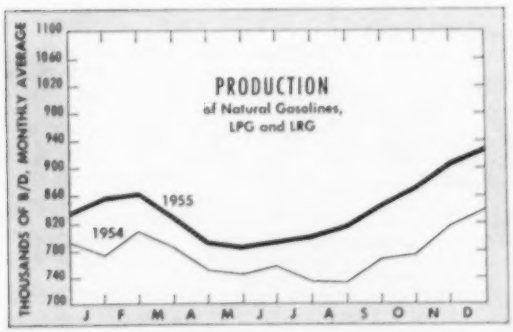
(Primary stocks include those at refineries, at large terminals and in pipelines; all data based on API reports)

District	RUNS TO STILLS (Millions of b/d average for week ending on date shown) Mar. 2 1956	Mar. 4 1955	Change	% Change	GASOLINE STOCKS (Millions of bbls. on date shown) Mar. 2 1956	Mar. 4 1955	Change	% Change	RESIDUAL STOCKS (Millions of bbls. on date shown) Mar. 2 1956	Mar. 4 1955	Change	% Change
East Coast	1.167	1.045	+ .122	+11.7	37.533	35.371	+ 2.162	+ 6.1	10.440	7.883	+ 2.557	+32.4
Gulf Coast	2.727	2.539	+ .188	+ 7.4	39.533	38.810	+ .723	+ 1.9	7.588	5.550	+ 2.038	+36.7
Total Coastal	3.894	3.584	+ .310	+ 8.6	77.066	74.181	+ 2.885	+ 3.9	18.028	13.433	+ 4.595	+34.2
Appalachian	.221	.195	+ .026	+13.3	7.957	7.434	+ .523	+ 7.0	.623	.493	+ .130	+26.4
Ind.-Ill.-Ky.	1.420	1.406	+ .014	+ 1.0	40.286	40.800	— .514	— 1.3	3.562	2.822	+ .740	+26.2
Okla.-Kans.-Mo.	.782	.668	+ .114	+17.1	22.911	19.359	+ 3.552	+18.4	.930	1.093	— .163	—14.9
Other Inland	.679	.615	+ .064	+10.4	20.825	19.184	+ 1.641	+ 8.6	2.150	2.159	— .009	— 0.4
Total Inland	3.102	2.884	+ .218	+ 7.6	91.979	86.777	+ 5.202	+ 6.0	7.265	6.567	+ .698	+10.6
Total East of Calif.	6.996	6.468	+ .528	+ 8.2	169.045	160.958	+ 8.087	+ 5.0	25.293	20.000	+ 5.293	+26.5
California	1.097	.994	+ .103	+10.4	25.623	21.385	+ 4.238	+19.8	10.677	24.298	—13.621	—56.1
Total U. S.	8.093	7.462	+ .631	+ 8.5	194.668	182.343	+12.325	+ 6.8	35.970	44.298	— 8.328	—18.8

District	DISTILLATE FUEL OIL STOCKS (Millions of bbls. on date shown) Mar. 2 1956	Mar. 4 1955	Change	% Change	KEROSINE STOCKS (Millions of bbls. on date shown) Mar. 2 1956	Mar. 4 1955	Change	% Change	TOTAL MIDDLE DISTILLATE STOCKS (Millions of bbls. on date shown) Mar. 2 1956	Mar. 4 1955	Change	% Change
East Coast	25.902	22.705	+3.197	+14.1	8.639	8.041	+ .598	+ 7.4	34.541	30.746	+ 3.795	+12.3
Gulf Coast	10.932	9.136	+1.796	+19.7	3.154	3.089	+ .065	+ 2.1	14.086	12.225	+ 1.861	+15.2
Total Coastal	36.834	31.841	+4.993	+15.7	11.793	11.130	+ .663	+ 6.0	48.627	42.971	+ 5.656	+13.2
Appalachian	2.052	2.138	— .086	— 4.0	.824	.736	+ .088	+12.0	2.876	2.874	+ .002	—
Ind.-Ill.-Ky.	11.858	10.639	+1.219	+11.5	3.915	4.723	— .808	—17.1	15.773	15.362	+ .411	+ 2.7
Okla.-Kans.-Mo.	7.556	7.142	+ .414	+ 5.8	.759	.973	— .214	—22.0	8.315	8.115	+ .200	+ 2.5
Other Inland	4.662	4.212	+ .450	+10.7	.991	.953	+ .038	+ 4.0	5.653	5.165	+ .488	+ 9.4
Total Inland	26.128	24.131	+1.997	+ 8.3	6.489	7.385	— .896	—12.1	32.617	31.516	+ 1.101	+ 3.2
Total East of Calif.	62.962	55.972	+6.990	+12.5	18.282	18.515	— .233	— 1.3	81.244	74.487	+ 6.757	+ 9.1
California	8.686	9.960	—1.274	—12.8	.259	.358	— .099	—27.7	8.945	10.318	— 1.373	—13.3
Total U. S.	71.648	65.932	+5.716	+ 8.7	18.541	18.873	— .332	— 1.7	90.189	84.805	+ 5.384	+ 6.3

Natural Gas and Refinery Gas Liquids





SUPPLY AND DEMAND STATISTICS

(Bureau of Mines Data)

CURRENT PRODUCTION

(1000 b/d monthly average)	Dec. 1955	Nov. 1955	Dec. 1954
At Natural Gasoline and Cycling Plants			
Liquefied Petroleum Gas	434	419	372
Natural Gasoline and Isopentane	271	281	263
Condensate	23	24	25
Finished Gasoline, Naphtha and other	69	63	73
Total Natural Gasoline and Cycling Plant Production	797	787	733
Liquefied Refinery Gases	134	122	107
Total Marketable Gas Liquids	931	909	840
Lease Condensate	122	118	107
Total Natural Gas Liquids	1,053	1,027	947

CURRENT DEMAND (1000 b/d monthly average)

LPG and LRG	674	591	544
Natural Gasoline, Isopentane and Other	354	377	356
Total Marketable Gas Liquids	1,028	968	900

CUMULATIVE PRODUCTION (1000 bbls.)	Dec. 1955	Dec. 1954
LPG and LRG	175,452	158,081
Natural Gasoline, Isopentane and Other	132,139	128,221
Total Marketable Gas Liquids	307,591	286,302

CUMULATIVE DEMAND (1000 bbls.)

LPG and LRG	175,472	154,802
Natural Gasoline, Isopentane and Other	132,312	128,450
Total Marketable Gas Liquids	307,784	283,252

STOCKS (1000 bbls., end of month)	Dec. 1955	Nov. 1955	Dec. 1954
LPG and LRG	7,738	11,011	7,759
Natural Gasoline, Isopentane and Other	4,484	4,216	4,656
Total Stocks	12,222	15,227	12,415

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AMMONIA SYNTHESIS, process design and fabrication, bulletin 0-54-1; Foster Wheeler Corp. See adv't. p. 123.

ANALYSIS SYSTEM, combustion, data file 19J-46; A. O. Beckman, Inc. See adv't. p. 160.

CATALYSTS, many types and shapes, booklet; Harshaw Chemical Co. See adv't. p. 108.

CHLORINATORS, for slime control, booklet RA-2061-C; Wallace & Tiernan, Inc. See adv't. p. 168.

CLEANING COMPOUNDS, for process equipment, bulletin F-3751; Oakite Products, Inc. See adv't. p. 120.

CONTROL SYSTEMS, scanning and logging, bulletin 98268; Taylor Instrument Cos. See adv't. p. 161.

COOLING TOWER TESTING, booklet describes method; Marley Co. See adv't. p. 156.

FURFURAL, for solvent extraction, bulletin 203-A; Quaker Oats Co. See adv't. p. 26.

HOSE, rubber, for handling petroleum products, booklet; Boston Woven Hose & Rubber Co. See adv't. pp. 24-25.

ILLUMINATORS, gage, data unit available; Jerguson Gage & Valve Co. See adv't. p. 114.

INSULATION, industrial, pipe and block, folder; Philip Carey Mfg. Co. See adv't. p. 21.

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MIST ELIMINATORS, bulletin ME-106; Metal Textile Corp. See adv't. p. 34.

MIXERS, side and top entering, 8 catalogs and data sheets available; Mixing Equipment Co. See adv't. p. 44.

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REFRACTORY LININGS, hydraulic setting, brochure RC-28A; Johns-Manville. See adv't. p. 104.

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SCREENS, woven wire, various metals, bulletins 6, 7 & 8; Cleveland Wire Cloth & Mfg. Co. See adv't. p. 102.

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STEAM GENERATORS, for solid, liquid, and gaseous fuels, bulletins; Henry Vogt Machine Co. See adv't. p. 155.

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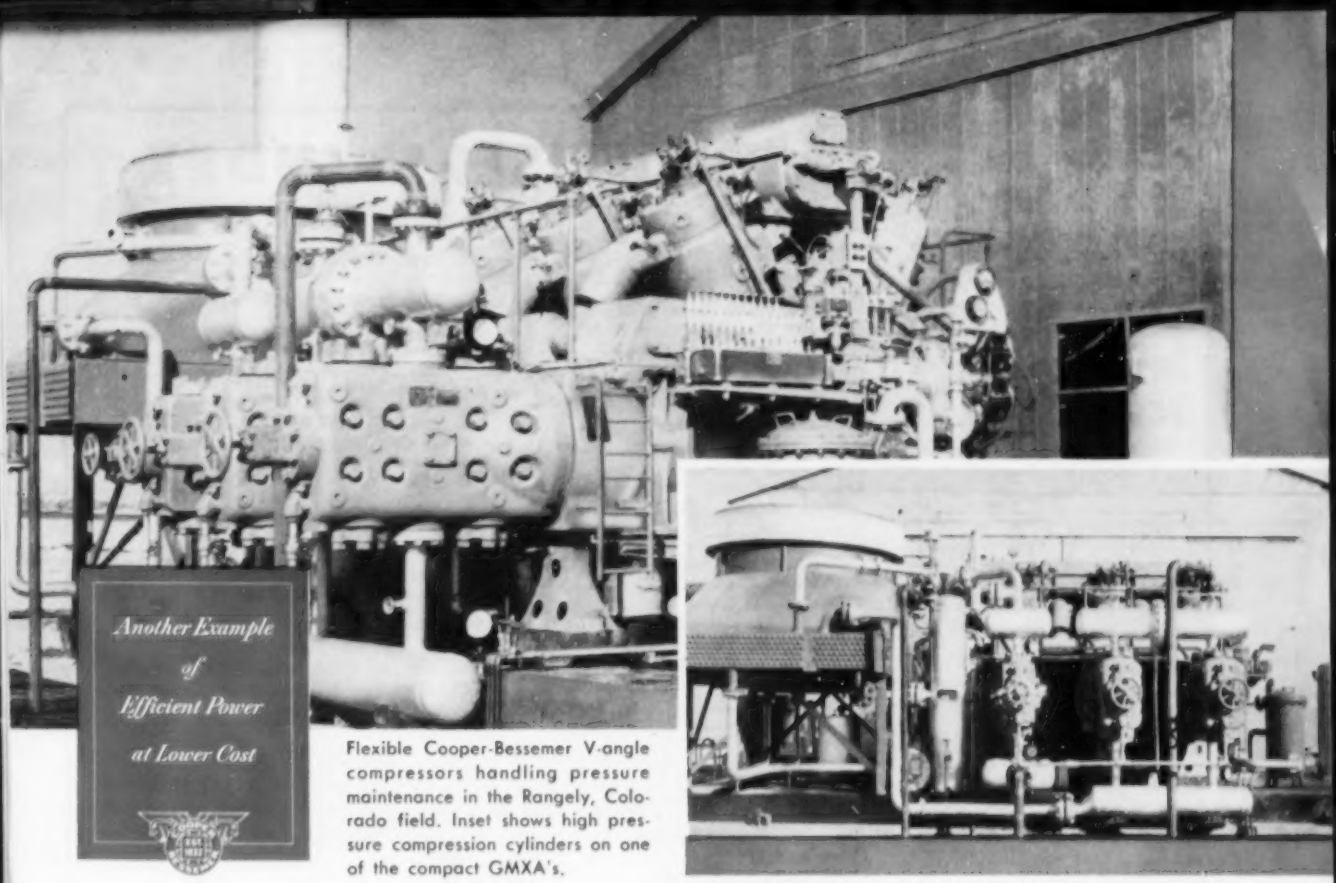
STEAM TRAPS, catalog contains complete data; Armstrong Machine Works. See adv't. pp. 42-43.

STEAM TRAPS, bulletin 10-55; W. H. Nicholson & Co. See adv't. p. 134.

TEMPERATURE INDICATORS, and recorders, new catalog; Electric Auto-Lite Co. See adv't. p. 166.

UNIONS, forged, types for various services, catalog 11; Catawissa Valve & Fittings Co. See adv't. p. 140.

VAPOR EQUIVALENT APPARATUS, for laboratory use, circular 1256; Central Scientific Co. See adv't. p. 20.



Flexible Cooper-Bessemer V-angle compressors handling pressure maintenance in the Rangely, Colorado field. Inset shows high pressure compression cylinders on one of the compact GMXA's.

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Each advertiser listed in this index has been assigned a code letter for use by the reader in securing additional information about advertised products, or services which interest him. This code letter appears in parantheses following the advertiser's name.

Circle the code letter on the "Advertised Product Inquiry" card (on the page opposite) which corresponds to that assigned the advertiser about whose product you want further information.

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● **The Heat Exchanger**—covering process and mechanical design, cost estimating factors, types of construction, etc. 32 pages—$1.00: Circle **R8**.

● **Vaporization Equilibrium Constant and Activity Coefficient Charts**—for conditions up to system critical point. 48 pages—$1.50: Circle **R1**.

● **Refinery Instruments, What Makes Them Tick?**—covering flow, level and temperature measurement; controllers, control valves and pneumatic transmission. 40 pages—$1.00: Circle **R2**.

● **Catalytic Reforming Survey**—with trends, theory and processes for catalytic reforming and aromatics recovery. 48 pages—$0.75: Circle **R3**.

● **Clip·n·File Sheets**—$0.20 each, any 6 for $1.00. Process Data Sheets **(PDS's)** are 3-page fold-outs with flow diagram, process description, conditions and economics. Engineering Data Sheets **(EDS's)** are two pages on special heavy paper to allow repeated handling and reference use.

PDS No. 1, **Ethylene Oxide**	Circle **R4**
PDS No. 2, **Butadiene·Butenes**	Circle **R5**
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PDS No. 4, **Ethylene—Kellogg**	Circle **R9**
PDS No. 5, **Fluid Coking**	Circle **R10**
EDS No. 1, **Pressure Fundamentals**	Circle **R7**
EDS No. 2, **Temperature Fundamentals**	Circle **R11**
EDS No. 3, **Fluid Flow Fundamentals**	Circle **R13**
EDS No. 4, **Flow Restrictions in Pipe**	Circle **R14**

Prices for quantity orders furnished on request.

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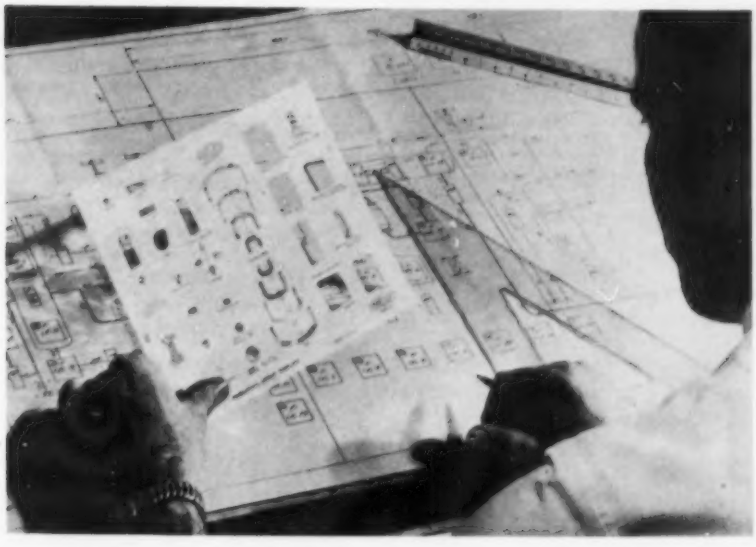


Drafting Template . . .

Helps Layout of Graphic Panels

A new drafting aid—called the "Panelgraph Layout Template"—has been developed by Panellit, Inc. Designed to reduce the time required for graphic panel layouts, the template has scaled outlines of the most frequently used industrial instruments. The scale is 2 in. to the foot—or 1/6 actual size. The template also contains outlines for pumps, valves, vessels, and other symbols usually represented on a graphic panel.

Based on its use in their own drafting room Panellit engineers claim that the template can cut drafting time in half for a complicated graphic layout. Although it was developed for their own drafting department where it has been used extensively, the Panellit template is now available to the instrument industry, and to any engineering group making their own graphic panels.

The template is made from 20-gage frosted plastic and is available at a price of $5.00. **Panellit, Inc.,** 7401 North Hamlin Ave., Skokie, Illinois.

Circle No. **1** *on Reply Card*

Non-Metallic Pipe

. . . **is now available** from another well-known steel tubing and pipe producer.

Two types of polyvinyl chloride pipe are available . . . a normal impact grade with high chemical resistance, and a high impact grade with less chemical resistance but greater strength. They are designated Carpenter "PVC No. 1" and Carpenter "PVC No. 2," respectively. Both types are easily fabricated on standard metal and woodworking equipment; and can be formed, sawed, threaded, machined, hot-gas-welded and solvent-welded.

The materials weigh one-sixth as much as steel pipe and have a friction loss one-half that of steel. The new PVC pipe is available in Schedules 40 and 80 in nominal sizes ranging from ½ in. to 4 in. All pipe is furnished in standard 10 and 20 foot lengths with plain ends. **The Carpenter Steel Co.,** Alloy Tube Division, Union, N. J.

Circle No. **2** *on Reply Card*

Cement for Plastic Pipe

. . . **makes joints stronger** than the pipe itself. It can be applied to polyvinyl chloride (PVC) pipe with a paint brush and will permit handling the pipe in an hour. Working strength is reached in 48 hours.

Developed by laboratory technicians, the new cement allows solvent welding of any PVC pipe approved by the Society of Plastics Industry. A recent example indicated that the use of this cement will appreciably reduce installation costs of plastic pipe.

A three-man crew with no previous experience was able to lay 3800 feet of 3 in. PVC pipe in less than two hours. The job included installation of 80 fittings. When the same crew laid a simliar line of screwed carbon steel pipe it required 4½ hours. The shorter installation time for the plastic pipe was attributed to the ease of solvent welding. **Tube Turns Plastic, Inc.,** 2929 Magazine St., Louisville 11, Ky.

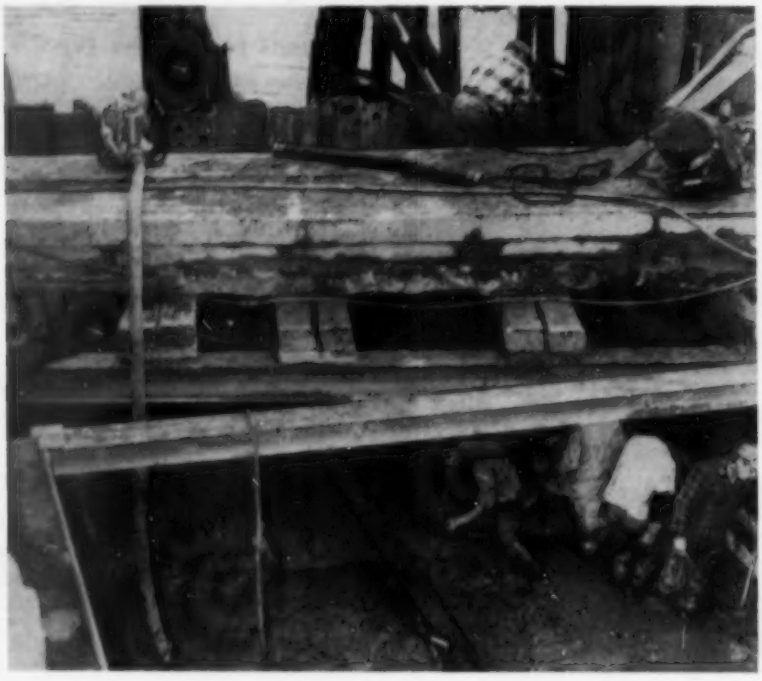
Circle No. **3** *on Reply Card*

Valve Swivel

. . . **features an inlet check valve** which prevents the hose from draining when the pump is shut off.

Made especially for liquid-dispensing nozzles and hose lines, this "No. 9" Swivel eliminates strain on the hose line and prevents rotary motion of the hose from causing kinking or twisting. The valve has an "O" ring which seals against any tapered machined surface. When the swivel body and tail are attached they will not pull apart under stress. **Ever-Tite Coupling Co., Inc.,** 245 West 54th St., New York 19, N.Y.

Circle No. **4** *on Reply Card*



Heavy Duty Pump . . .

Handles Mud or Sand

After on-the-job testing, a new diaphragm pump for muck, mud, sand and sewage is now in production and available for use. With a pumping capacity of 5,000 gal/hr., the Model 20DP3 is claimed to solve many of the de-watering problems encountered in field construction.

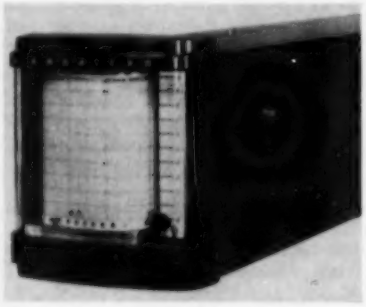
Easy to carry and move around, the new pump weighs only 120 lbs. It can be set up in almost any location and will run for 6 hours at full capacity, consuming only 1 gallon of fuel. Powered by a single-cylinder, two-cycle gasoline engine, the operating speed is between 1500 and 2850 rpm.

For different pumping conditions the engine can be hand-regulated by a throttle on the float-type carburetor —slow speed for seepage control and full speed for capacity pumping. At full throttle the pump makes approximately 63 strokes per minute.

Wear and maintenance is held to a minimum by using anti-friction bearings and heat-treated, cut steel gears in the pump end. The gears are completely enclosed and the flapper valves in the suction and discharge fittings are self-cleaning to prevent clogging.

The Model "20DP3" will dry-prime up to 15 feet., and has a guaranteed suction lift of 28 ft. Total head is 50 ft. It is supplied with 3-in. fittings and can be adapted for use with a 2-in. hose. **Homelite,** 75 Riverdale Ave., Port Chester, N. Y.

Circle No. **5** *on Reply Card*



Graphic Panel Recorders

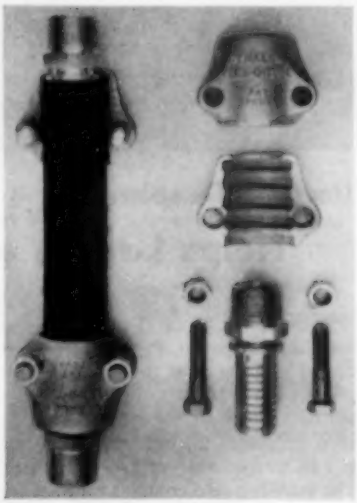
. . . **produce a permanent record** on either continuous strip charts or IBM card charts.

The new "American-Microsen" Series 130 electronic recorder is available as a microammeter, in ranges from 0-200 microamperes to 0-100 milliamperes—or as a millivoltmeter, in ranges from 0-20 millivolts to 0-100 volts. Input sensitivity to 6700 ohms per volt is available.

The recorder measures input signals with an electro-mechanical transducer and amplifier, which drives a rotary solenoid to position the pen. A feedback spring from the pen arm to the input transducer force balances the pen position with the input signal. The resulting power eliminates the usual limitations of low-level electrical measurements, i.e., pivot friction errors, vibration effects and excessive maintenance.

Accuracy is within 0.5% of the range and repeatability is better than 0.25% of range. The recorder will respond to input changes of less than 0.2% of range. High or low alarm contacts can be furnished with it. Controls Division, **Manning, Maxwell & Moore, Inc.,** Stratford, Conn.

Circle No. **6** *on Reply Card*



Two-Bolt Hose Clamp

. . . **permits easy replacement** of fittings on high pressure hoses with ratings up to 3,000 psi.

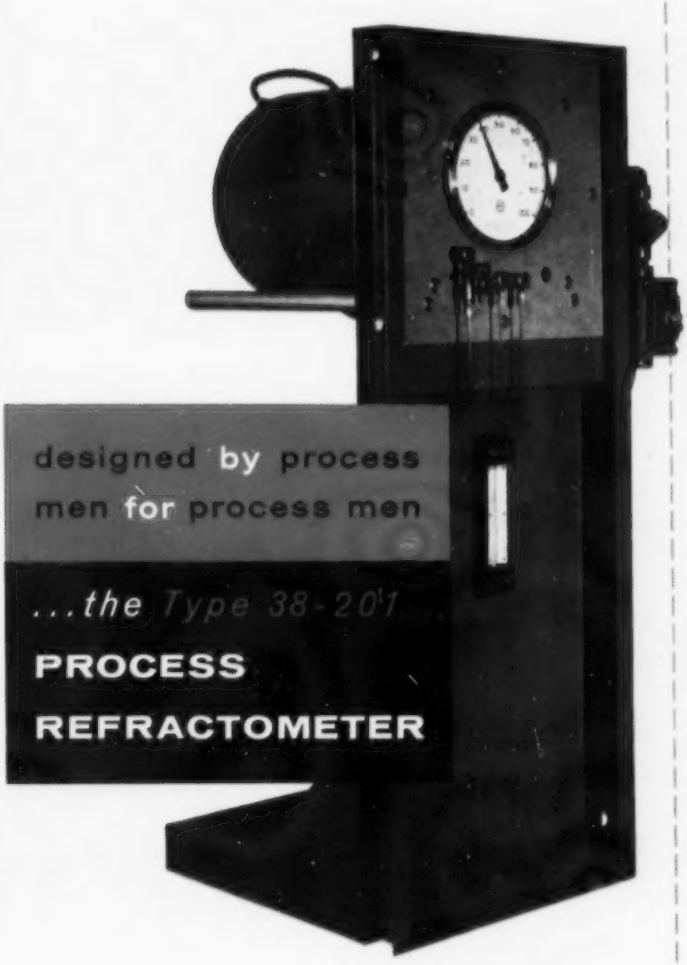
The Flex-O-Tube "Dynalok" clamp fitting is made of heavy malleable iron and is secured with two large heat-treated bolts. Besides use as a replacement fitting it can be taken off and be easily reassembled again. The formed clamp permits accurate assembly by maintenance personnel.

For use with all standard-type high pressure hoses of the proper dimension, the triple wire braided hose and clamp are rated for pressures up to 3,000 psi. With double wire hose it is also rated up to 3,000 psi. However, with single wire hose it has a 2,500 psi rating; and used with two fiber braided hose, it is rated for service up to 1,500 psi. **Flex-O-Tube Div. of Meridan Corp.,** 2525 Jim Daly Rd., Inkster, Mich.

Circle No. **7** *on Reply Card*

Here's a process-control instrument built on experience . . . CEC's 38-201 Process Refractometer. This process analyzer was proved *around the clock* for several years in actual process operations at the various refineries of its original designer, the Phillips Petroleum Company. Now, as a "Consolidated-Phillips" instrument, it's backed by Consolidated Electrodynamics' nationwide service organization . . . assurance of interruption-free service for years to come. And CEC's experienced Application Service is available to discuss applications, diagnose problems or aid in the development of new automatic analysis and control systems.

Here's above all a *practical* process monitor and controller, which can materially lower your costs and raise both throughput and quality. For the complete story of the 38-201 Process Refractometer, write today for Bulletin CEC-1839 X20.



What it measures . . .

. . . the 38-201 measures the difference in refractive index between a liquid standard and a flowing liquid sample obtained *directly from a process line*. Refractive index is related to density and thus is able to provide a direct indication of relative composition changes in binary mixtures. When the process stream is complex, a binary mixture is approximated when all but one or two key compounds remain reasonably constant.

Its features . . .

RUGGED CONSTRUCTION—explosion-proof design permits use anywhere, even out-of-doors.

STABLE, DRIFT-FREE OPERATION—the differential-principle design provides freedom from ambient temperature changes. Sample temperature, pressure and flow are closely controlled and stabilized.

HIGH SENSITIVITY—maximum full-scale sensitivity is 0.0012 Refractive Index Units, minimum is 0.24. Unit observes both plus and minus deviations of the flowing sample.

SIMPLICITY—contains no controls requiring routine adjustment; once unit has been placed in operation, the operator makes only an occasional inspection.

FREEDOM FROM MAINTENANCE—basic design simplicity keeps unit operating without attention for long periods. If repairs are required, all electronic and optical assemblies are easily reached, and can be replaced quickly with standardized spare units.

How you can use it . . .

FRACTIONATOR CONTROL—Process Refractometers are saving hundreds of dollars per day through maintenance of product composition at Phillips Petroleum Company.

AUTOMATIC CONTROL—readily achieved by making the Process Refractometer an element of a feedback loop. Deviations from the desired R.I. then automatically adjust process parameters to bring end product back to standard.

BLENDING CONTROL—by using a sample of correctly blended liquid as the standard, the Process Refractometer, through use of variation in the sample R.I. to actuate pneumatic controllers, automatically controls blending operations, cuts losses from faulty product.

The Consolidated-Phillips group also includes:

38-101 Infrared Gas Analyzer | 38-301 Oxygen Analyzer | 38-401 Ultraviolet Analyzer

Consolidated Electrodynamics
CORPORATION
Formerly Consolidated Engineering Corporation
ELECTRONIC INSTRUMENTS FOR MEASUREMENT AND CONTROL
300 North Sierra Madre Villa, Pasadena, California
Sales and Service Offices in: Albuquerque, Atlanta, Boston, Buffalo, Chicago, Dallas, Detroit, New York, Pasadena, Philadelphia, San Francisco, Seattle, Washington, D. C.

(To obtain more data on advertised products see page 142)

EVER-TITE
Standard Adapter
and Coupler

Your best buy is

EVER-TITE
-the best quality
QUICK COUPLINGS

EVER-TITE
Adapter and
Coupler

You save *time* and *money* when you use Ever-Tite Couplings because they speed-up deliveries, prevent leakage, and save wear on equipment.

Tightness is predetermined in manufacture by positive gasket compression. There are no sliding rings—no springs, ball bearings, snaps or lugs to fit. You just slip the coupler over the adapter, and close the handles.

If you want to get the *most* in coupling value get *Ever-Tite*. The Ever-Tite Trademark is a hallmark of dependability in fittings for the petroleum industry—proved by 18 years of pre-eminence. Ask your distributor now.

EVER-TITE
Shank Hose
Coupling

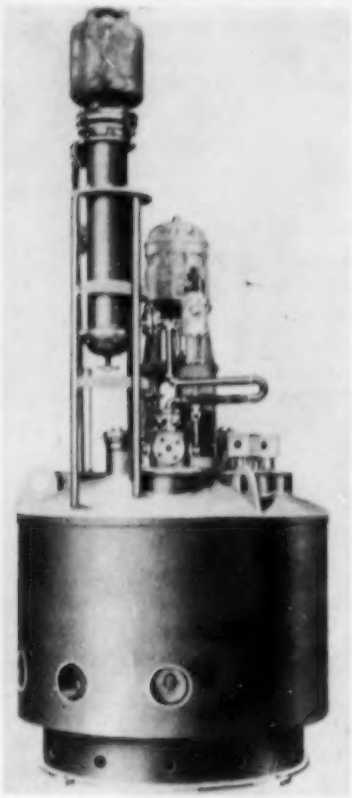
EVER-TITE COUPLING CO. INC.
254 West 54th Street
New York 19, N. Y.

Dust Plug

Dust Cap

EVER-TITE Dust Protectors

Every EVER-TITE saves time and money



Heat Transfer Unit

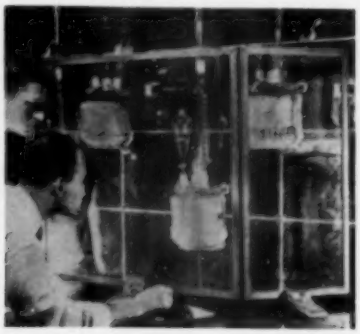
. . . **uses molten salt** for process temperatures between 650 and 1000°F.

Heat is transferred by molten salt from the unit itself to process vessels at no pressure. Close control of temperature is possible by regulating the amount of electric energy put into the molten salt. The molten salt is circulated throughout the heat transfer system by a submerged impeller pump.

For laboratory use at temperatures between 650 and 1000°F, the Beth-Tec heating system uses a eutectic heat transfer salt marketed by DuPont as "Hi-Tec." A range of heating capacities from 10,000 to 250,000 Btu/hr. is available in three tank sizes. A low-temperature cut-out prevents operation of the pump until the salt is molten. A high temperature alarm sounds at a limit of 1000°F.

The salt heat transfer medium has negligible vapor pressure. And it is non-toxic, non-corrosive, non-fouling and chemically stable and inexpensive. For exothermic reactions the same system can be hooked up with a cooler which will remove the excess heat. **Bethlehem Foundry & Machine Co.,** Bethlehem, Pa.

Circle No. **8** *on Reply Card*



Safety Shield

. . . **with special features** gives greater protection to lab personnel.

Instead of clamping the shield to its feet with wing bolts, a broad vise-like jaw closed by lever action permits gripping the laminated glass shield with greater safety. Accidental bumping of the shield will not break the glass; neither will excessive tightening of the clamp when using the new jaws. The increased clamping area also permits lifting the shield with feet attached for moving to a new location.

The shield itself is available as a wrap-around protector, with two side panels attached to the main front panel. The three-piece shield will extend to a full frontage of 58 by 30 inches. Either the safety shield or the special "Safety-Sure" foot is available separately. **Fisher Scientific Co.,** 711 Forbes St., Pittsburgh 19, Penna.

Circle No. **9** *on Reply Card*

Combustible Gas Analyzer

. . . **is portable** and completely self contained, except for a source of 110 volt power.

It is a continuous sampling system, operated by a motor-driven pump mounted inside the unit. A visible meter always indicates the gas or vapor concentration being tested. Both visual and audible "high gas" signals

GENERAL REFRACTORIES

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Pack your bag, jump in your car, board your ship, your train, your plane—join America on the go. And thank brick that you *can* go. Refractory brick that produces the concrete for your highway, the turbines for your ocean liner, the stainless steel for your streamliner, the wings for your plane.

Everything that's made or that moves owes its existence to the fires of industry contained by valiant walls of refractory brick—refractories which withstand enormous heat for days, for weeks, for years.

How great the heat to be mastered? Where? When? How long? These are the concern of the refractory scientist, and it is the mission of General Refractories Company to meet the requirements.

To do this job, General Refractories maintains the world's greatest refractories laboratory, draws on resources the globe around for materials, and makes and distributes exactly the right refractory to industry, everywhere.

A Complete Refractories Service

GENERAL REFRACTORIES COMPANY

Philadelphia 2

A COMPLETE REFRACTORIES SERVICE FOR THE PETROLEUM INDUSTRY

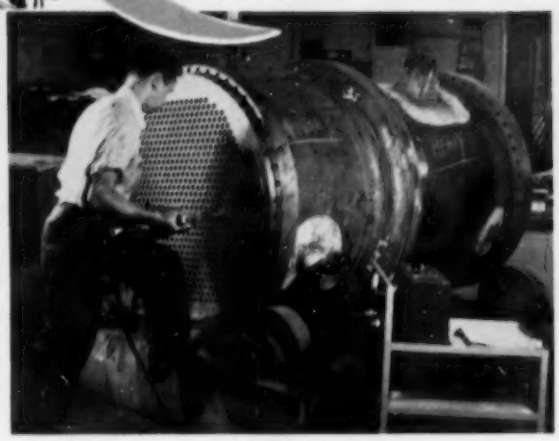
LITECAST 50—A hydraulic-setting insulating castable refractory material, having a density of approximately 50 lbs. per cubic foot. Its extreme light weight and exceptionally low thermal conductivity make it an efficient and economical heat insulator. Recommended for vessel linings and backing for brickwork for other heavier castable refractory materials.

HIGH-STRENGTH BRIK-CAST—A hydraulic-setting castable refractory material unique in that it contains more bonding agent, which results in a product more resistant to the physical actions of impact, erosion, and load bearing. Used extensively for lining regenerator chambers and catalyst lines in catalytic cracking units.

LITECAST 50-M—A 50-pound density insulating castable, having a high degree of purity, used as a liner in vessels and lines where atmospheres must be controlled, or contamination of internals must be avoided. LITECAST 50-M may be applied in the same manner as standard hydraulic-setting castables.

BRIK-CAST 3000—A hydraulic-setting castable refractory material, composed of clays and bonding agents having the highest purity, resulting in a product with a high operating temperature (3000° F.), and resistance to reducing atmosphere in carbon monoxide attack. Recommended for sulphur burner chambers and other vessels operating above normal cracking and reforming temperatures.

Roll perfect tube joints fast . . . with AIRETOOL!



So simple to operate, even the most inexperienced man can turn out perfect tube bundles, fast!

AIRETOOL'S new, electrically controlled automatic tube expansion control system makes it possible to roll perfectly bonded tube joints in half the time usually required by old manually controlled methods. With the AIRETOOL Expansion Control System, the ball bearing type expander is controlled by an electric motor regulated by the control system. When tubes have reached the proper expansion and tightness, the control mechanism automatically shuts off the power. Seven motors, covering every range of power needed, are available for use with the control. You simply set the calibrated dials for the type of metal and tube size, and you're ready to go to work. Can you afford to continue operations without these AIRETOOL advantages . . .

- **Cuts Maintenance Cost**
- **Boosts production output**
- **Eliminates over-expansion**
- **Permits tubes to be rolled to maximum tightness without injury to tube ends or distortion to tube sheet ligaments**
- **Eliminates cold worked metal stresses in tubes**
- **Gives tight, leak-proof joints every time**
- **Cuts tube rolling failures to absolute minimum**
- **Completely portable**

We'll be glad to give you an on-your-job demonstration. Contact your nearest AIRETOOL representative, or write, wire or phone the AIRETOOL Mfg. Co., 318 S. Center St., Springfield, Ohio. Also ask for full details and information on AIRETOOL tube maintenance equipment suited to your needs.

AIRETOOL
MANUFACTURING COMPANY
316 S. Center St.
SPRINGFIELD, OHIO

BRANCH OFFICES: New York, Chicago, Tulsa, Philadelphia, Houston, Baton Rouge.
REPRESENTATIVES in all principal cities of U.S.A., Canada, Mexico, South America, England, Europe, Puerto Rico, Italy, Japan, Hawaii.
EUROPEAN PLANT: Vlaardingen, The Netherlands

indicate approach to lower explosive limits. A built-in "trouble indicating" circuit tells of any difficulty with the indicating light or audible signal. Operating power required is 100 watts from a 110 volt, 60 cycle source. **Davis Instruments,** 47 Halleck St., Newark 4, N.J.

Circle No. **10** *on Reply Card*

Tilting Motor Base

. . . automatically takes up belt stretch and absorbs starting loads.

The "Tens-A-Matic" motor base reduces the time required to change a belt by allowing the motor to be tilted forward and blocked in place during the operation. After the belt is installed the base permits proper tension adjustment for the new belts. There is no need to realign the motor or the belts. The base is available for motors ranging in size from fractional to 200 hp. **Murray Equipment Co., Inc.,** 11350 Schafer, Detroit 27, Mich.

Circle No. **11** *on Reply Card*

New Pressure Gage

. . . operates under prolonged exposure to high temperatures and radiation. It will give readings up to 200 psi under a constant 100°F, and operate in a radiation flux of 1 million Roentgens per hour.

The instrument consists of a pressure-sensing bellows, a differential transformer and a meter to indicate variations in the transformer output. It operates by measuring the change in electrical output in the secondary of the differential transformer caused by movement of the core. By direct linkage the core is connected to the bellows. Any change in pressure on the bellows causes a directly proportional movement of the core. This in

to meet exacting lubrication standards, specify

ENJAY PARATONE®

viscosity-index improver

Refiners and blenders rely on Enjay Paratone for compounding oils that combine cold-weather, quick-starting properties with low consumption characteristics.

You can also count on Enjay for a prompt solution to your additive problems. The Enjay Company, pioneer in petroleum additives, has extensive experience in working with oil companies and leading engine manufacturers to develop additive formulations. Whatever your use of additives, you can benefit from this experience.

For complete information, write or call the Enjay Company—your only source of a *complete* line of additives (Paramins®) for fuels and lubricants.

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Pioneer in Petrochemicals

ENJAY COMPANY, INC., **15 WEST 51st STREET, NEW YORK 19, N. Y.** • Other offices: Akron, Boston, Chicago, Tulsa

Here's How to Handle Corrosives at High Peripheral Speeds

CHEMLON YARN PACKING STYLE C-30 Made of TEFLON* FIBER BY "JOHN CRANE"

Chemlon Yarn Style C-30 extra tough packing gives you two important advantages not provided by other types of braided or molded Teflon packing: 1) positive sealing efficiency at high peripheral speeds; 2) cooler running stuffing box under severe service conditions.

Style C-30 can be used to handle the most destructive acids, alkalis or solvents. The excellent thermal properties of Teflon, combined with the softness, resiliency and fluid retentive properties of fine fiber construction, adapt it to high temperature conditions to +300°F. The packing is made firm and dense by means of a special process which eliminates *large* voids.

HERE'S PERFORMANCE PROOF:—Fluid handled: 45% H_2SO_4 (impure) at 170°F.—Operating conditions: 1¼" pump shaft at 1700 rpm. or 555 fpm. peripheral speed. Results: 46 days good service. Previous best service record 7 to 10 days.

Chemlon Yarn Packing Style C-30 is available in spool or coil form, in a wide range of sizes from ⅛" up. *Can be lubricated with Teflon suspensoid or various types of lubricants.*

Send for Bulletin No. P-321. Crane Packing Co., 6432 Oakton St., Morton Grove, Ill. (Chicago Suburb)

In Canada: Crane Packing Co., Ltd., Hamilton, Ont.

*DuPont Trademark

JOHN CRANE **CRANE PACKING COMPANY** 38 YEARS INDUSTRIAL PROGRESS

OFFICES IN ALL PRINCIPAL CITIES

turn induces a variation in the electric output of the transformer.

Since many applications of this type of gauge are in systems where leakage is detrimental, the bellows, located immediately below the transformer, serve as a secondary seal. The bellows and transformer constitute one compact unit connected by cable to the receiver. The gauge is not temperature sensitive. **Callary Chemical Co.,** 201 N. Braddock Ave., Pittsburgh 8, Pa.

Circle No. **12** *on Reply Card*

Signalling Tachometer

. . . **not only indicates speed** but signals overspeeds and underspeeds through self-contained power relays.

The high and low speed pointers adjust independently, so that they may be used for sounding alarms, turning on signal lights, opening or closing valves or other applications at any desired speed settings. A manual reset push button is used to reset the tachometer after the relays have signalled a high or low speed.

Any one of 48 different scales, marked in any rate such as rpm, fpm, etc. is available. **Metron Instrument Co.,** 432 Lincoln St., Denver 3, Colorado.

Circle No. **13** *on Reply Card*

Pipe Coating

. . . **claims superior corrosion resistance,** after one-year ship board testing.

An extensive one-year test with sour crude oil held aboard the "S.S. Bulk Star," owned by National Bulk Carriers, was made to determine the corrosion-resistance of a new coating of nickel-alloy. Installed as a section of the heating coils in the #3 centerline

. . . there's enough difference to make ALL the difference

Every single finished Scovill Heat Exchanger Tube is subjected to a 1,000-lb. hydrostatic pressure test and an 80-lb. air pressure test under the eyes of experienced inspectors. Very seldom does a tube fail at this point; yet this and other final inspections for tube perfection are always rigidly maintained.

Before Scovill Heat Exchanger Tubes reach these final inspection benches, specialized production methods and controls have already assured their inherent uniformity in alloy composition . . . with soundness in metal structure . . . and dense, smooth surfaces, free from defects. Scovill safeguards assure delivery to customers of tubes in top physical condition . . . an essential to dependable heat exchanger service.

Scovill Technical Service stands ready to help you select the correct tube alloys for your applications, with recommendations based on most comprehensive experience records.

Scovill Manufacturing Company, Mill Products Division, 99 Mill Street, Waterbury 20, Connecticut. Phone: Plaza 4-1171.

SCOVILL HEAT EXCHANGER TUBE

Phosphorized Admiralty • Admiralty • Arsenical Admiralty • Muntz Metal • Naval Brass • Red Brass, 85% • Deoxidized Copper
Arsenical Copper • Copper Nickel, 10% & 20% • Cupro Nickel, 30% • Aluminum Brass • Aluminum Bronze, 5% • Duplex Tube

119C56

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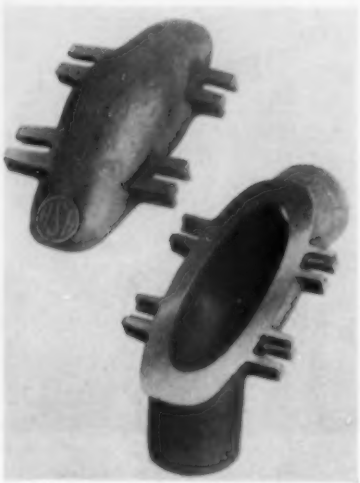
VALVES
CENTRIFUGAL PUMPS
Throughout your plant
. . . wherever you have stuffing boxes to be repacked, specify Durametallic "Engineered For The Job" products for longer packing life and satisfactory sealing service.
Write today for our packing File No. DMPP
DURAMETALLIC CORP.
KALAMAZOO, MICHIGAN
COMPRESSORS
RECIPROCATING PUMPS

cargo tank, it was subjected to severe corrosion action of the hot sour crude oil and salt water ballast. The test section was in constant service for the entire test period of one year.

Conducted by the New York Testing Laboratories, the test is claimed to prove that the life of the heating coils can be increased several times. Normal life of uncoated mild steel heating coils without repair has been only 6 months in this service. The cost of replacement is estimated at over $90,000 per ship. **Niphos Process Sales Corp.,** 19 Rector St., New York City.

Circle No. **14** *on Reply Card*



Impact Fittings

. . . **for pneumatic material-handling systems** can be reversed or replaced when subjected to abrasive use.

Made from an especially hard alloy (Ni-Hard) that provides a high abrasion resistance (Brinell hardness of 550), the wear-back is designed for long service. The fitting bodies are cast from "Ashcolite" metal—a hard, chrome-iron alloy with a Brinell hardness of 340 to 360.

Because it can be reversed in service, wear can be distributed over the entire wear-back, greatly increasing the life of the fitting. A cast insignia readily indicates whether the piece is in its original position or has been reversed. The discharge end is elongated to remove the pipe connection as far as possible from eddies created by the turn, which reduces wear at the connection.

Cast with plain ends, the fittings are connected to straight sections of pipe with sleeve couplings and thus allows easy alignment with the pipe. Adaptors for connection of the fitting to flanged

LITHIUM METAL AND ALLOYS
LITHIUM HYDRIDE
LITHIUM HYDROXIDE
LITHIUM CARBONATE
LITHIUM CHLORIDE—BRINE—ETC.

LITHIUM
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Pioneers in Lithium since 1901

MAYWOOD CHEMICAL WORKS
MAYWOOD, NEW JERSEY
ESTABLISHED 1895

THIS 400,000 Pounds per HOUR

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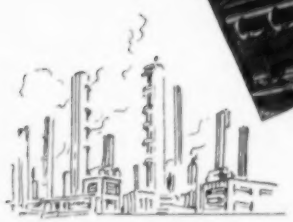
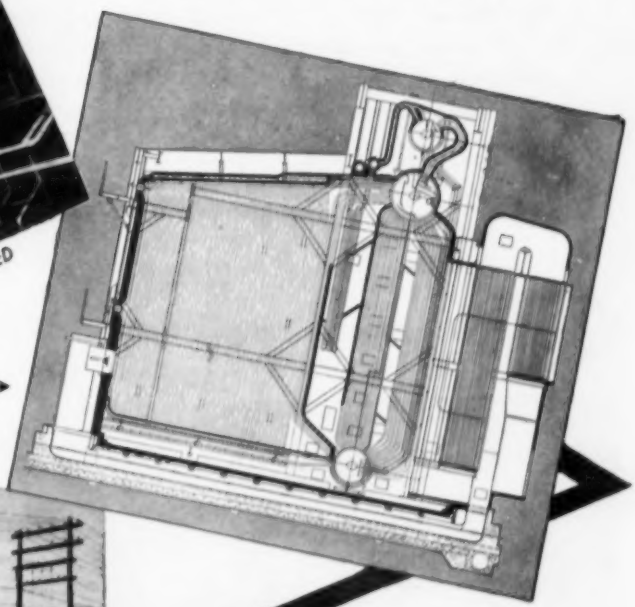
STEAM GENERATOR

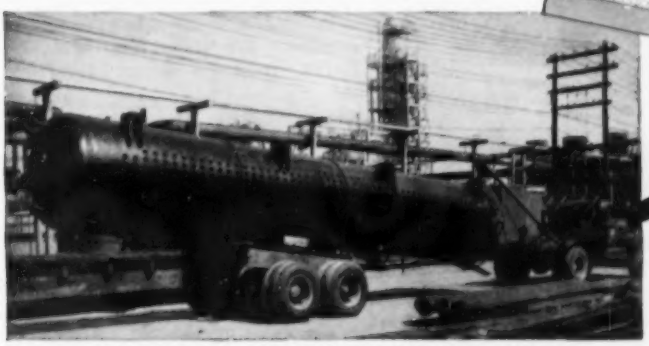
Gives Top Performance in a Leading Texas Petroleum Refinery

VIEW OF THE COMPLETED STEAM GENERATOR



RIGHT →
LONGITUDINAL SECTION THROUGH THE UNIT.





6'-6" DIAMETER x 37'-0" LONG STEAM DRUM BEING TRANSPORTED TO THE ERECTION SITE DURING INSTALLATION.

PRINCIPAL DATA

400,000 pounds per hour capacity.

Fusion welded steam and water drums designed for 700 lbs. S.W.P.

Superheater delivers steam at 750°F. total temperature.

Water cooled furnace.

Burners for Oil and Acid Sludge fuel.

Vogt builds a complete line of bent tube steam generators designed to burn solid, liquid, or gaseous fuels to meet specific operating conditions. Write for bulletins.

Dept. 24-BPP

HENRY VOGT MACHINE CO., LOUISVILLE 10, KY.

SALES OFFICES: New York, Philadelphia, Chicago, Cleveland, Cincinnati, St. Louis, Dallas, Charleston, W. Va., San Francisco

There is every reason—
and now is the season—to
TEST YOUR TOWER

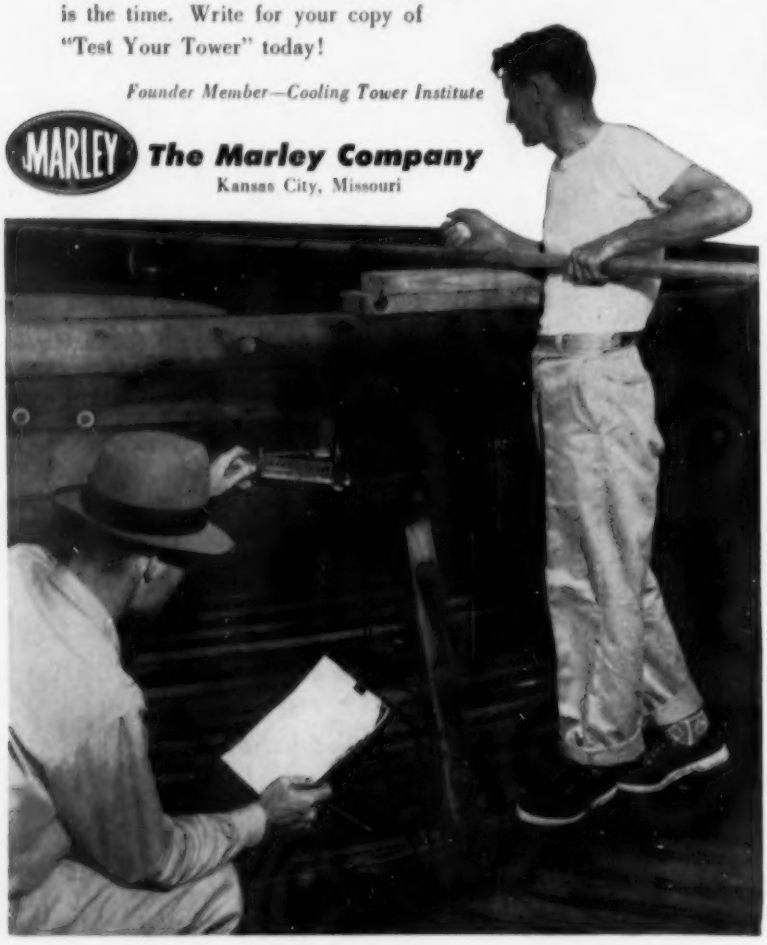
Thanks largely to Marley's "Test Your Tower" crusade, it is generally accepted today that the purchaser of a cooling tower is entitled to proof of positive performance. Only a test is proof positive—and the best season of the year for tower testing is at hand.

So if you haven't done so already, write today for Marley's, technical bulletin, "Test Your Tower". It offers a simple, proven method by which you can determine how closely your actual tower performance measures up to specified performance. Such information is well worth knowing, particularly in those industries where the whole tempo of operations is closely geared to temperature of process cooling water. Knowing your tower's capabilities and limitations will also help you make sound plans for the future if you have purchased a tower with plant expansion in mind.

Whatever your situation, it pays to test, and now is the time. Write for your copy of "Test Your Tower" today!

Founder Member—Cooling Tower Institute

MARLEY **The Marley Company**
Kansas City, Missouri



pipe or connections are available. **Allen-Sherman-Hoff Co.,** 259 E. Lancaster Ave., Wynnewood, Pa.

Circle No. **15** *on Reply Card*

Air-Operated Cleaner

. . . **offers no explosion hazards** and creates a high vacuum by use of compressed air only.

Connected to existing compressed air lines, this new vacuum cleaner will develop suction twice as great as an equivalent sized electric unit. It is also claimed the suction is greater than that created by a 7½ hp. electric type this is several times greater in unit size.

The "Vac-U-Max" has no electric connections and no moving parts. The suction is based on an aerodynamic principle, and uses 25 cubic feet of free air per minute. Its capacity is 20 gals., and overall size is 33 in. high by 24 in. diameter.

Usable for either wet or dry pickup, the vacuum cleaner collects solid waste in a reusable burlap bag within the container. For wet pickup, the fluid is drained from the bottom of the unit through a drain cock. **American Balmes Corp.,** 859 Summer Ave., Newark 4, N. J.

Circle No. **16** *on Reply Card*

Free Trade Literature

DC Motors

. . . of fractional horsepower sizes are described in *Bulletin GEA-6068.* The illustrated bulletin covers the complete line of these motors and includes typical application descriptions, ratings and specifications. General Electric, Schenectady 5, N. Y.

Circle No. **17** *on Reply Card*

Testing Instruments

. . . are listed in a 92-page catalog. Many instruments are described in detail, along with pictures of the equip-

New cost-cutting TRICKLE FLOW process uses low hydrogen recycle to get 99.5% desulfurization of gas oil

With 80% hydrogen purity, the new SHELL TRICKLE FLOW process yields doctor-sweet product at lower cost.

TRICKLE FLOW operation offers you these five additional advantages:

1. **Smaller, simpler, easier-to-maintain plant**
2. **No need to rerun product**
3. **High liquid yields**
4. **Sustained catalyst activity**
5. **Uses a rugged, low-cost catalyst**

Flexible TRICKLE FLOW process has been refinery-proved, and now is successfully turning out a premium product in the modern Canadian Petrofina Refinery. This unit was engineered by the Lummus Company.

We'll be glad to supply further information about this efficient, low-cost desulfurization process. Address your inquiry to:

SHELL DEVELOPMENT COMPANY
50 West 50th Street, New York 20, New York

SHELL

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MINERS OF COPPER, ZINC, IRON AND SULFUR.

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CONTRACT REQUIREMENTS SOLICITED . . .

We are in a position to supply your needs on annual, semi-annual, or monthly contract basis — also smaller quantities in drop shipment lots.

TYPICAL ANALYSIS

Copper	37.00%	Minimum
Moisture	12.00%	Maximum
Fe	.04%	Maximum
Zn	.01%	Maximum
Water Soluble	more than 99.50%	
Insoluble as copper oxychloride	less than .50%	

CHECK THESE *FEATURES:*

√	HIGHER COPPER CONTENT
√	LOWER MOISTURE
√	FINER PARTICLE SIZE
√	UNIFORMITY
√	AVAILABILITY

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Other Tennessee Corporation products, Ferric Sulfate (Ferri-Floc), Copper Sulfate, and Sulfur-Dioxide.

For Samples . . . Make request on your company letterhead.

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Classified Advertising Division

PETROLEUM PROCESSING

330 West 42nd Street **New York 36, New York**

ment. Some of the items presented are viscometers, constant temperature baths, ovens, timers, balances and other apparatus found in physical testing laboratories. Gardner Laboratory, Inc., Bethesda, Md.

Circle No. **18** *on Reply Card*

Instrument Bulletins

. . . provide up-to-date information on new equipment. *Bulletin 7040* describes small-case, indicating pressure controllers available in ranges from 0-50 and 0-200 psi. *Specification Sheet 242-2* describes mechanical flow meters with evenly graduated charts and scales. *Specification Sheet 248* covers the specifications of a differential converter with mercuryless transmitters. And *Bulletin 7202* explains the design of quick-connect "Tel-O-Set" instruments. Minneapolis-Honeywell Regulator Co., Industrial Division, Wayne and Windrim Aves., Philadelphia 44, Pa.

Circle No. **19** *on Reply Card*

Synthetic Lubricants

. . . made from polyalkylene glycols and derivatives. *Form 6500D*, a 52-page booklet, fully describes the uses, properties, and applications of these new products. Of particular interest is the section dealing with their use as high and low temperature lubricants, and their special uses in hydrogen and natural gas compressors. These fluids have high viscosity indexes, low pour points and are wax-free, non-carbonizing and non-corrosive to metals. Carbide and Carbon Chemicals Co., 30 East 42nd St., New York 17, N. Y.

Circle No. **20** *on Reply Card*

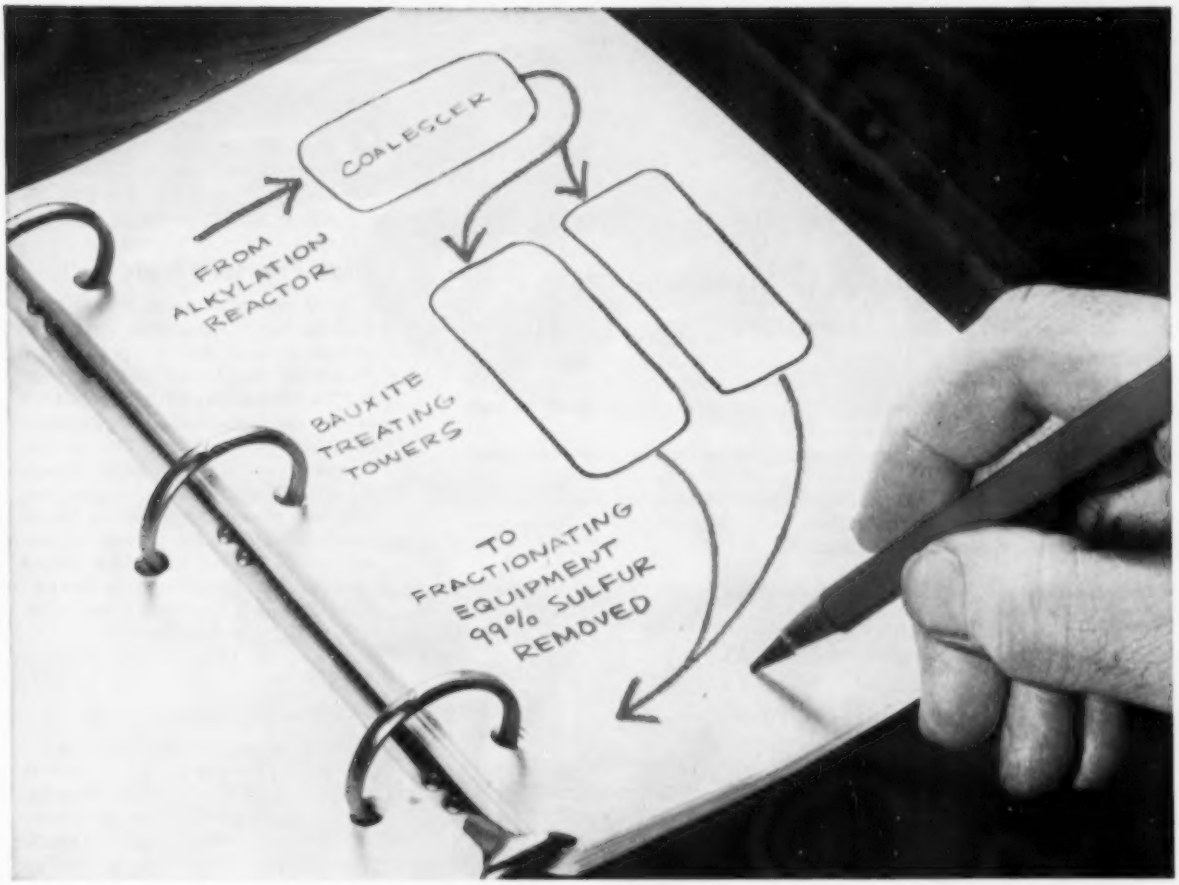
Searching For Oil

. . . a popular booklet published by the American Petroleum Institute, is now available in an up-to-date version. Originally written as an answer to queries directed to the API, it is now rewritten for the general public due to its previous popularity. Included are the latest statistics, as well as easy-to-read graphs covering historical data on drilling activity, production and reserves, and the cost of finding and producing oil. American Petroleum Institute, Department of Information, 50 West 50th St., New York 20, N. Y.

Circle No. **21** *on Reply Card*

Heat Transfer Bulletin

. . . contains data and pictures for custom-built equipment users. *Bulletin HE* includes a table of heat transfer



The Answer to Alkylation Maintenance

New bauxite process removes 99% sulfur from alkylation reactor effluent

Reduced corrosion, decreased fouling in alkylate fractionating units, and savings in tetraethyl lead result from a new bauxite process of treating reactor effluent which has been developed jointly by D-X Sunray Oil Company and The M. W. Kellogg Company.

Sixteen months' experience with this process shows that it removes 98 to 99% of acid and both acidic and neutral esters from the alkylation reactor effluent. This compares with 65% sulfur removal obtained in conventional caustic wash systems.

The new bauxite process uses a coalescer to provide the equivalent of added settling time. This horizontal vessel separates suspended microscopic drops of acid and sulfur hydrocarbons. The effluent then percolates down through medium mesh bauxite in one of the two treating towers, where acid and esters are preferentially adsorbed. The towers are alternately regenerated.

This new process not only eliminates maintenance problems caused by residual acid, but also saves tetraethyl lead, due to the improved lead susceptibility of the sulfur-free alkylate. Additional advantages include lower acid consumption and elimination of inhibitors.

The process is licensed by The M. W. Kellogg Company. Design data are available for five standard sizes, ranging from 5,000 to 25,000 bpsd. of reactor effluent.

Refinery Process Division

THE M. W. KELLOGG COMPANY

225 Broadway, New York 7, N. Y.

The Canadian Kellogg Company, Ltd., Toronto • Kellogg International Corp., London

SUBSIDIARIES OF PULLMAN INCORPORATED

Now *simpler, more accurate control of oxygen in*

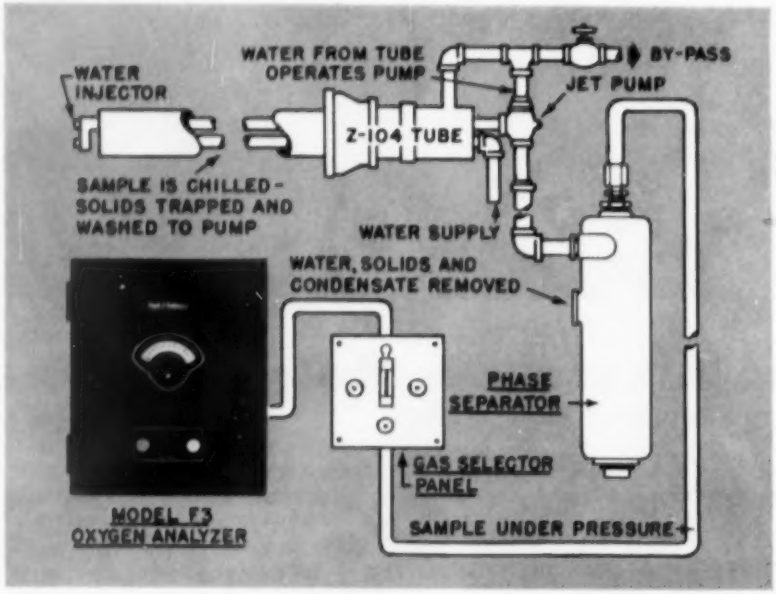
BOILERS...FURNACES...KILNS...DIRECT-FIRED HEATERS, ETC.

with Arnold O. Beckman INC.

complete Analysis Systems!

Arnold O. Beckman, Inc. – leaders in developing advanced instrumentation for accurate oxygen control – now offers *complete* analysis systems for higher combustion efficiencies at lower fuel costs.

These field-proven systems are already being used by progressive operators to boost profits, cut costs – and they will make the same savings for *you*. They consist of Analyzer, and Sampling System – all in one compact installation suitable for indoor or outdoor location. For severe temperature conditions, heated cabinets can be supplied.



The diagram (above) shows a typical analysis system for boilers. The incoming sample gas is first chilled and washed . . . then passes through a Separator where the condensables and solids are removed. The resulting clean, dry sample gas flows under pressure to the Gas Selector Panel (for selecting "Zero," "Span" and "Sample" gases) . . . then into the Analyzer where the oxygen content is quickly measured. The Analyzer may be used with any standard recorder or controller.

Result – new speed, simplicity and accuracy in controlling air-fuel ratios, with important savings in fuel and operating costs!

Get the full story on these Complete Analysis Systems by writing for Data File # 19J-46.

Arnold O. Beckman INC.
ANALYZERS
Profit Builders for Industry
1020 Mission Street
South Pasadena, California

rates for various duties, tubesheet layout tables and a sample calculating sheet. Details of heat exchanger construction are also described. Downington Iron Works, Inc., Downington, Pa.

Circle No. **22** *on Reply Card*

High Pressure Meters

. . . with capacities up to 30,000 gpm: *Bulletin No. 571* describes three types of high pressure meters—positive displacement, double-case and the Granco "Duo-Rotor" meter, which consists of two counter-rotating dynamically balanced rotor turbines. This booklet includes metering principles, dimensions and specifications, engineering data and pressure-drop charts for all three models. A description of the accessories for use with these meters (with working pressures up to 300 psi) is also included. Granberg Corp., 1308 67th St., Oakland 8, Calif.

Circle No. **23** *on Reply Card*

Expansion Joints

. . . design guide: *Catalog #153*, a 24-page manual, presents the factors which must be considered in the solution of pipeline expansion problems. The different types of expansion joints, how they are constructed, as well as what their design limitations are, are all described in this guide. Much information is presented in the form of charts and tables: both are used in solving a sample design problem. Flexonics Corp., Maywood, Ill.

Circle No. **24** *on Reply Card*

Fire Pumps

. . . their drives, ratings and typical installations: *Bulletin No. B-1500*, a 36-page manual, describes all the horizontal types of centrifugal pumps that are approved by Underwriter's Laboratories and Factory Mutual Fire Insurance Companies, and that are available from Peerless Pump Division of Food Machinery and Chemical Corp., 310 West Avenue 26, Los Angeles 31, Calif.

Circle No. **25** *on Reply Card*

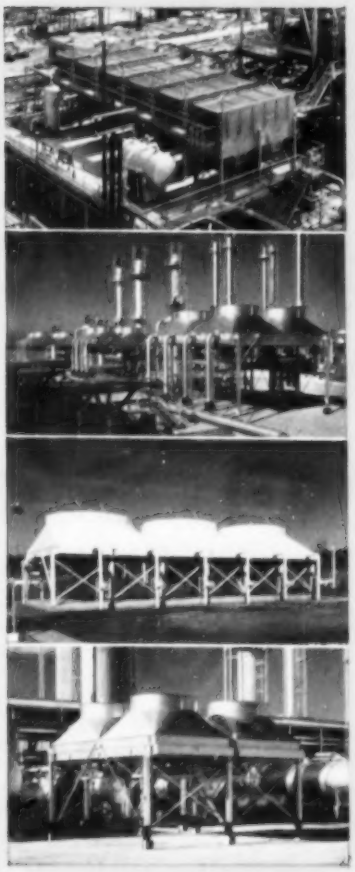
Ethanolamines

. . . are fully described in 54-page technical data book of the same title. The book describes and lists the many applications of mono-, di-, and triethanolamines. Included are their chemical and physical properties, physiological properties, shipping specifications; handling and storage procedures, and a comprehensive bibliography. Graphic illustrations include data pertinent to

HUDSON LEADS THE WAY
In Equipment For

Cooling with Air

More than 600 HUDSON Solo-aire and Combin-aire Units are giving complete satisfaction both in mechanical operation and in meeting cooling performance specifications in . . .



OIL REFINERIES

Solo-aire Units, installed in space formerly occupied by water box submerged coolers, are used for condensing and oil cooling, eliminating water circulation of 4200 gallons per minute. Previous high maintenance costs due to water scaling and corrosion are also eliminated.

GAS PROCESSING PLANTS

Solo-aire Units as pictured at left, and Combin-aire Units, are minimizing water consumption, lowering water treatment costs, and lowering over-all maintenance expense in scores of Gas Processing Plants in the United States, Europe, Pakistan and South America.

COMPRESSOR STATIONS

Solo-aire Units are installed in many of the larger main line Compressor Stations in the United States for cooling gas, jacket water, and lube oil. HUDSON auto-variable pitch fans allowing accurate, automatic control of cooler outlet temperature are used in many of these installations.

CHEMICAL PLANTS

Vapor at 550°F. is condensed and condensate subcooled in Solo-aire pictured at left. In services for cooling of very high temperature fluids, and cooling of fluids with which water contamination must be avoided, Solo-aires are particularly adapted.

Experience The first HUDSON exchangers using air as the cooling medium were installed over 20 years ago for condensing exhaust steam. Thru constant research, improvement and innovation in design and in manufacturing techniques, and in development of units for special applications, HUDSON reached and has retained its position of leadership in "Cooling with Air."

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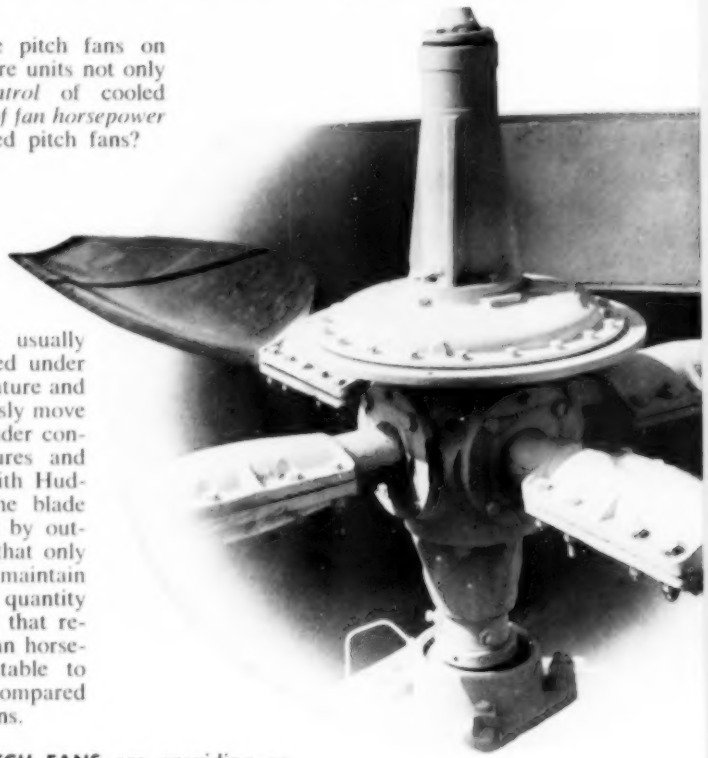
FAIRVIEW STATION • HOUSTON, TEXAS

LARGE POWER SAVINGS
and Accurate, Automatic Temperature Control with HUDSON AUTO-VARIABLE PITCH FANS

WHY do Hudson Auto-variable pitch fans on Hudson Solo-aire and Combin-aire units not only *give accurate temperature control* of cooled streams, but — *save up to 85% of fan horsepower* compared with conventional fixed pitch fans?



BECAUSE fixed pitch fans are usually selected to move the air required under conditions of summer air temperature and maximum heat load, and needlessly move such maximum quantity even under conditions of winter air temperatures and lower-than-design heat loads. With Hudson Auto-variable pitch fans the blade pitch is automatically controlled by outlet cooled fluid temperature so that only the quantity of air required to maintain this temperature is moved. This quantity in winter may be only 30% of that required in summer, resulting in fan horsepower saving of 85% attributable to Auto-variable pitch fans as compared with conventional fixed pitch fans.

OVER 200 AUTO-VARIABLE PITCH FANS are providing accurate, trouble-free temperature control in Hudson Solo-aire and Combin-aire units. Minute changes in cooled fluid outlet temperature immediately and automatically changes pitch of fan blades, increasing or decreasing flow. Control is effective despite changes in heat load or hot fluid inlet temperature; and over ambient air temperature range of more than 150° F.

Consult Hudson for more detailed information on the application of Auto-variable pitch fans to present or future installations.

HUDSON AUTO-VARIABLE PITCH FANS

- **Accurately control temperature.**
- **Effect major savings in power.**
- **Reduce cost of control equipment.**
- **Eliminate by-pass piping.**
- **Prevent freezing even in extremely cold weather.**
- **Operate with standard pneumatic instruments.**
- **Have all moving parts of control mechanism completely enclosed and weather-proofed.**

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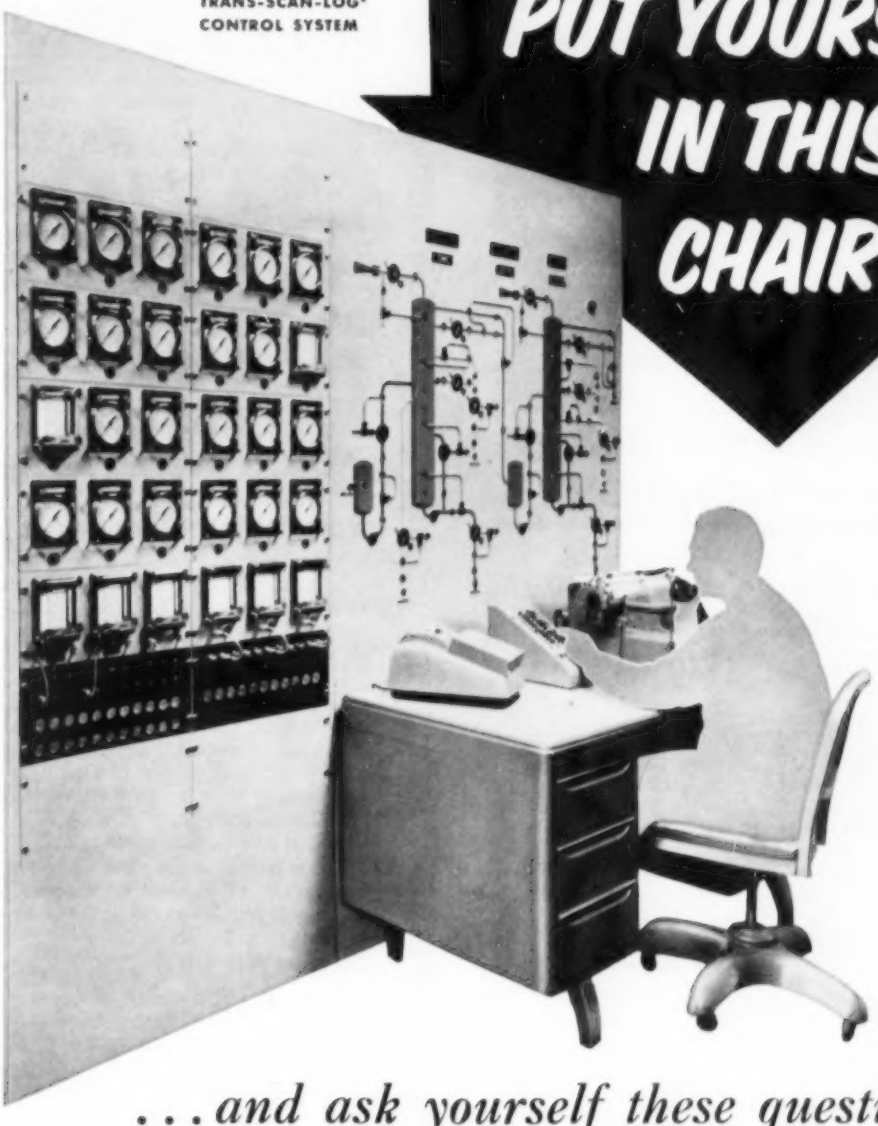
TAYLOR
TRANS-SCAN-LOG*
CONTROL SYSTEM

PUT YOURSELF IN THIS CHAIR



. . . and ask yourself these questions

Is scanning and logging, as I understand it, economically justified?

Perhaps not, if you're thinking just of mechanical logging of all variables, which gives little more than an accurate historical record of what has happened. But the new Taylor TRANS-SCAN-LOG System makes the operator more than a score-keeper. It enables him to instantly *visualize, evaluate* and *act upon* every processing irregularity as it occurs — without leaving his desk in front of the panel.

What effect would the TRANS-SCAN-LOG System have on my control room space and operator requirements?

It will take approximately 60% of the space normally required by a standard graphic panel *without* scanning and logging. The compactness of this "intelligence center" enables operator to supervise a greater percentage of the process. Because the scanning and logging equipment is an integral part of the process control, one operator can identify and correct any off-normal condition, as well as having a continuous trend record.

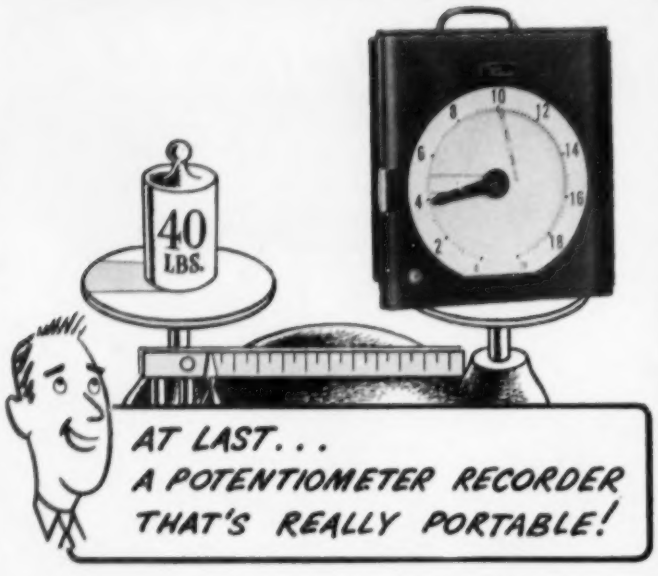
Where can I see this unit in operation?

We cordially invite you to come to Rochester to see this complete data collecting system in operation, because we believe that its many unique features *do* make it economically justified.

Your Taylor Field Engineer will be glad to make the necessary arrangements. In the meantime, write for **Bulletin 98268.** Taylor Instrument Companies, Rochester, N.Y., or Toronto, Canada.

*Trade Mark

Taylor Instruments
MEAN ACCURACY FIRST



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A POTENTIOMETER RECORDER
THAT'S REALLY PORTABLE!

In response to the increasing demand in industry for a truly portable indicating recorder, we have redesigned our standard Thermo Electronic Recorder . . . making it 18 lbs. lighter . . . without sacrificing either accuracy, sensitivity or durability.

In addition to recording temperatures in 19 standard ranges, from −100° to +100° F. up to 0° to 3000° F., it is also used to measure humidity, solution conductivity, speed, pH, direct current, DC voltage, power, strain, or any other measurement that can be converted to a change in resistance or DC millivoltage.

The simple design of the electronic balancing system of this instrument employs only three moving parts, and nylon drive gears and cam rolls are used throughout for quiet, durable operation.

A cam is used to drive the recording pen, thus permitting linear charts to be used for almost all measurements, despite the non-linearity of the sensitive element characteristics.

SPECIFICATIONS

CHART
Circular, 12" diameter, 4⅛" scale width, uniform graduations.

CHART DRIVE
Synchronous, electric, 24-hour revolution standard, other speeds available.

CALIBRATION ACCURACY
±¼ of 1% of scale span.

BALANCE CONTROL ACTION
Continuous null, positive drive of slidewire and pen, no galvanometer, unaffected by vibration.

SENSITIVITY
One slidewire turn (less than ±1/20 of 1% of scale).

DIMENSIONS
16⅞" wide by 18⅛" high by 7½" deep.

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40 lbs.

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Write for catalog Section 60-100-I covering this latest addition to the growing T-E line.

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viscosities, vapor pressure, densities, freezing curves and other characteristics. A copy of the book is available by writing on your company letterhead to Nitrogen Division, Dept. EA, Allied Chemical & Dye Corp., 40 Rector St., New York 6, N. Y.

Do Not Use Reply Card

Platinum Catalysts

. . . as used in hydrogenation and catalytic reforming: one of the many uses of the platinum group metals described in *Form 4683-55-3MX*, a 24-page booklet reviewing present-day uses of this type catalyst. A section with technical data on various processes is included. Baker & Co., Inc., 113 Astor St., Newark 5, N.J.

Circle No. **26** *on Reply Card*

Heat Exchanger Manual

. . . for design of Pyrex brand modular glass shell-and-tube heat exchangers: 16-page *Bulletin PE-33* is designed to help the engineer choose the right equipment for a glass heat-exchange system. Engineering data for determining capacity requirements of a 50-square foot, and a 13½-square foot exchanger systems are included. Charts and other information on fluid constants, friction losses, surface area calculations and thermal gradients can be found in the manual. Plant Equipment Sales, Corning Glass Works, Corning, N. Y.

Circle No. **27** *on Reply Card*

Sodium Nitrite

. . . for rust and corrosion prevention is the subject of a booklet issued this year for those interested in corrosion inhibition. Twenty years ago this chemical was used in patented compounds for rust-free anti-freezes. Today it is used by some oil companies to protect pipe lines, tankers, and storage vessels. Used in quantities as small as 200 ppm, sodium nitrite dissolved in entrained water will protect petroleum product equipment against corrosion. Solvay Process Division, Allied Chemical & Dye Corp., 61 Broadway, New York 6, N. Y.

Circle No. **28** *on Reply Card*

PVC Pipe

. . . is described in *Technical bulletin 80-3*, which gives engineering data on "Ryertex-Omicron" polyvinyl chloride pipe. This is the plastic pipe that has long been used in Europe and is now being produced in this country. The material is resistant to most industrial

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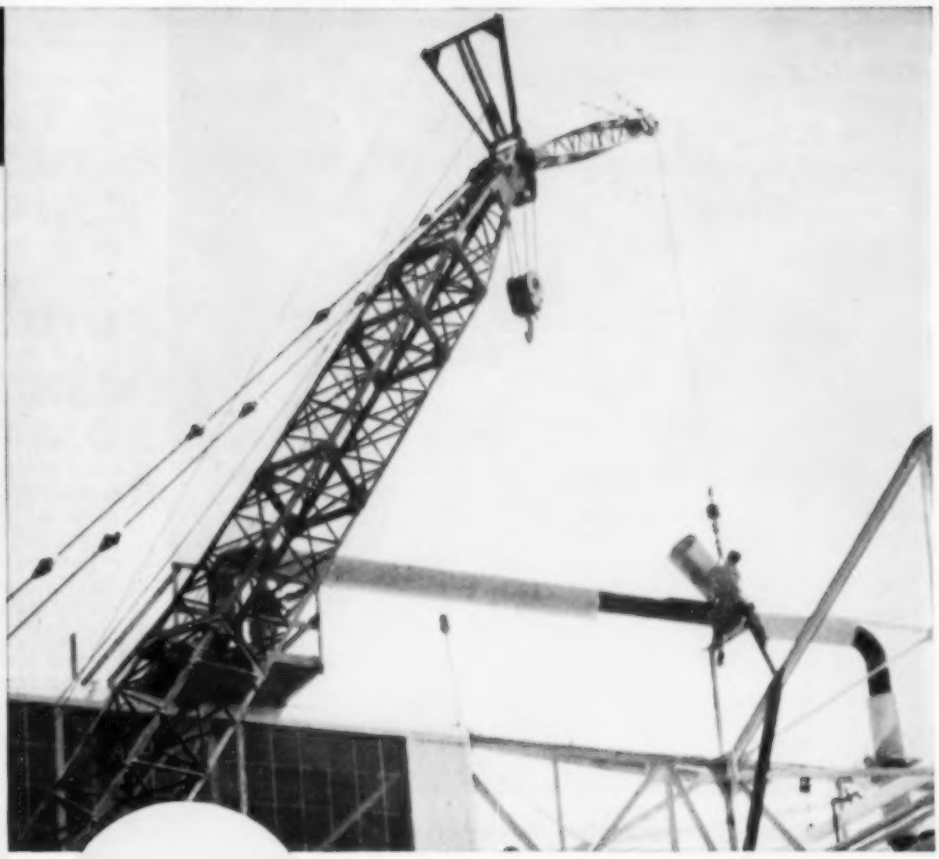

Anyone can apply SNAP*ON anywhere!

Versatile is the word for G-B Snap*On, the new one-piece pipe insulation molded of fine glass fibers. Whether you need pipe insulation for hot or cold piping, in the plant or outside, in ¾" to 33" sizes, Snap*On is the pipe covering for you. Anyone can handle this new lightweight and indestructible insulation . . . anyone can apply it by simply spreading the single seam and snapping the material over the pipe.

As the photo indicates, if you can put a man in contact with a run of pipe, he can quickly insulate it all by himself with Snap*On. The one-piece construction of Snap*On reduces labor cost of installation one-third, in many cases. Waste is nil, even though plant workmen have never used the product before nor received any special training in its application.

If you can't say as much for your present pipe insulation, call your nearby Snap*On distributor whose phone number is shown in the adjoining column. He'll furnish you samples and complete technical data that will prove to you that for thermal efficiency, low-cost application, and permanence, there's nothing like G-B Snap*On. Call him today.

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Thermal and acoustical glass fiber insulations • Pipe couplings and fittings • Molded glass fiber pipe insulation

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(To obtain more data on advertised products see page 142)

Safety for an aircraft test facility at Pratt & Whitney Aircraft Plant, using BS&B Model DV Rupture Discs.

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Now Handle Even "Tougher" Applications With The New Model DV Rupture Disc . . .

FEATURES OF THE MODEL DV DISC

- ✓ Unrestricted, Instantaneous Opening In Sizes 1" Through 36".
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- ✓ Minimizes Metal Creep Due To Elevated Temperatures And Pressures.
- ✓ Pressure Ratings: 5 lbs. To Several Hundred Pounds.
- ✓ Temperature Ranges: Sub-Zero To 900° F.

- **High Temperature**
- **Alternating Pressure and Vacuum**
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BS&B — ANOTHER EXAMPLE OF PRODUCT LEADERSHIP

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Safety Head Division, Dept. 2-D4
7500 East 12th Street Kansas City 26, Missouri

chemicals except organic solvents. The pipe is available in standard sizes from ½ to 8 in. in Schedule 40 and 80 weights. Larger sizes are available by other than extrusion methods of production. Joseph T. Ryerson & Son, Inc., P.O. Box 8000-A, Chicago 80, Ill.

Circle No. **29** *on Reply Card*

V-Belt Drives

. . . and their historical development are presented in a 36-page pocket size booklet. Describing the origin, history and developmenet of the modern V-belt drive, the booklet covers the evolution of standards in these drives and provides tables and data for design purposes. The final chapter is devoted to questions that are often asked in the engineering of multiple V-belt drives. Allis-Chalmers Manufacturing Co., 1218 S. 70th St., Milwaukee, Wis.

Circle No. **30** *on Reply Card*

Exchanger Tubes

. . . are described in a technical folder, *Bulletin TB-329B*. It includes all pertinent information on the various grades of carbon, alloy and stainless steel tubing for heat exchangers and condensers. Both seamless and welded tubing is described in this technical folder, which also includes a special section dealing with the problems of installing tubes by the expanding method. Babcock & Wilcox, Beaver Falls, Pa.

Circle No. **31** *on Reply Card*

Electric Controller

. . . parts catalog: *Catalog No. 55* lists in 96 pages all the most frequently used parts of various manufacturers' equipment, including everything from A(armatures) to Y(yokes). Illustrations accompany most of the descriptions. A separate 12-page price list covers each controller manufacturers' most popular and frequently used parts and renewal kits. Brownell Distributors, Inc., 306 Canal St., New York 13, N. Y.

Circle No. **32** *on Reply Card*

Scientific Discoveries

. . . stumbled onto by accident: a 64-page booklet, "Accidental Scientific Discoveries," describes twenty important scientific advances associated with such names as Priestley, Rontgen and Fleming. Included are the stories of the discoveries and work associated with petroleum jelly, plastics, benzene ring, acetylene and other topics of scientific history. Copies available

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(To obtain more data on advertised products see page 142)

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LEVEL
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Auto-Lite Temperature Indicators are ideal for use in processing and storage rooms, and for installation on equipment where temperature indication is desirable.

Model F-1 (illustrated) is available with maximum visibility dial; choice of temperature ranges from minus 60°F to plus 750°F; flexible tubing for remote reading or rigid stem for direct mounting. Adjustable electrical alarm contacts slightly higher. Priced from $22.

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Chemical Rubber

. . . has great resistance to deterioration. *Bulletin A-509* describes the composition and methods of manufacturing "Hypalon," a chlorosulfonated polethylene. This vulcanizable rubber is made by reacting polyethylene with chorline and sulfur dioxide. The product has great resistance against oxidizing agents or ozone, and it is claimed concentrations as high as 60,000 parts per million of ozone have no affect on "Hypalon" compounds. Elastomers Division, E. I. duPont de Nemours & Co., Inc., Wilmington 98, Del.

Circle No. **33** *on Reply Card*

Cathodic Protection

. . . against existent corrosive action, or to prevent corrosion damage on new installations. This is the subject for a technical brochure, "Cathodic Protection Systems for Corrosion Control." The possible savings resulting from cathodic protection to underground pipe lines is illustrated with case histories. The Harco Corp., 16963 Broadway, Cleveland, Ohio.

Circle No. **34** *on Reply Card*

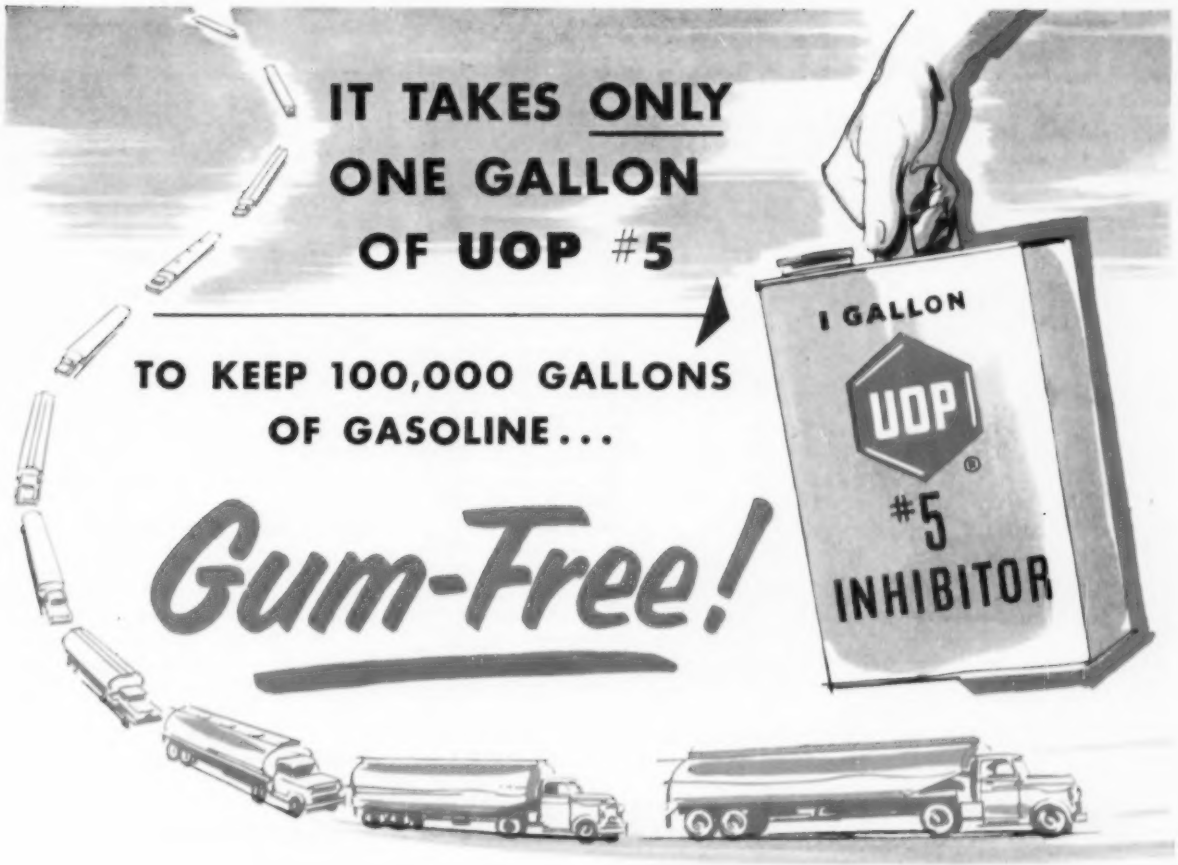
Corrosion-Proof Exchangers

. . . are made of impervious graphite. Two new types of heat-exchange units, the cubical and the cross-bore, are described in *Bulletin No. 537*. The cubical unit provides the greatest possible amount of transfer per unit volume by containing all heat transfer within a small graphite cube. The cross-bore exchanger uses a one-piece cylindrical bundle and has the same overall dimensions as a standard tube-and-shell unit. Both exchangers have cross-drilled passages in solid blocks of impervious graphite. Design pressure is 150-200 psi. Falls Industries, Inc., Aurora Road, Solon, Ohio.

Circle No. **35** *on Reply Card*

Pipe Fittings, Flanges

. . . made of unplasticized polyvinyl chloride: *PVC Pipe Fittings & Flanges*, a booklet describing the history of this material, its advantages, and the dimensions of fittings made from it. Included are tables of chemical resistance, flow vs. pressure loss, recommended support spacing, operating



UOP #5 Inhibitor is the most economical you can use. And by experience and test it is also the best—the only inhibitor that can handle the really tough stability jobs.

Actually, only 5 molecules of UOP #5 will protect as many as 1,000,000 molecules of today's tailor-made gasoline from the formation of gum, the one universally recognized cause of engine manifold deposits. It's effective, too, in preventing the decomposition of TEL in stored gasoline. Is it any wonder that UOP #5 is the standard of comparison in the industry?

Just as the methods of making better gasoline keep changing, so do the techniques of finishing gasoline for maximum gum stability and engine cleanliness. We will be glad to share our experience in this field with you in attacking a current stability problem or in reducing costs on present processing. Just write us.

PRODUCTS DEPARTMENT

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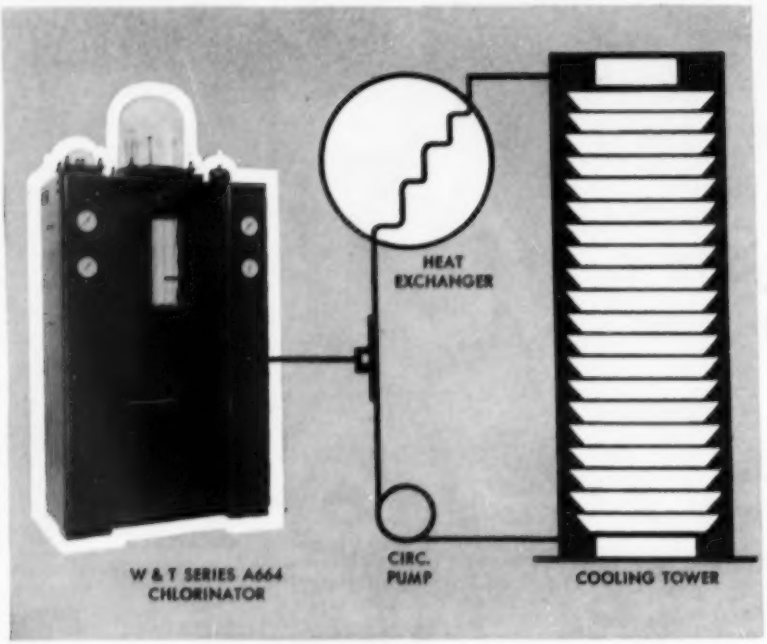
UNIVERSAL OIL PRODUCTS COMPANY

30 ALGONQUIN ROAD, DES PLAINES, ILLINOIS, U. S. A.

Slime Control...



...Chlorination of Cooling Water Circuits

Heat transfer losses caused by slime formation on condenser and heat exchanger water-side surfaces can be eliminated by chlorination of the cooling water. Water and air-borne organisms—the cause of slime formations—are effectively and economically controlled by Wallace and Tiernan chlorination systems.

The Wallace and Tiernan Series A-664 Chlorinator shown above is one of a complete line of W&T chlorination equipment, designed to give dependable chlorination at all feed ranges. It is used at large plants where cooling water chlorine requirements call for a durable high capacity unit.

We Invite Your Inquiries

Technical information on cooling water chlorination is available in our free booklet, RA-2061-C. Bulletins on chlorination of industrial process water and industrial waste treatment are also available. Write us for your copy.

WALLACE & TIERNAN INCORPORATED
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CD-40

pressures, and physical properties of three different grades. Tube Turns Plastics, Inc., 2929 Magazine St., Louisville 1, Ky.

Circle No. **36** *on Reply Card*

Physical Properties

. . . of synthetic organic chemicals: *Booklet F-6136*, a 24-page edition tabulates data on more than 350 organic chemicals, arranged by related groups with information on applications. Carbide and Carbon Chemicals Co., 30 East 42nd St., New York 17, N. Y.

Circle No. **37** *on Reply Card*

Softeners, Clarifiers

. . . for water: their design and selection are discussed in *Technical Reprint T-135*. The increasing industrial use of high-rate clarifiers and softeners, based on advantages of smaller size, shorter retention time, and lower cost, are discussed in this reprint. Graver Water Conditioning Co., 216 West 14th St., New York 11, N. Y.

Circle No. **38** *on Reply Card*

Piping Insulation

. . . made from asbestos, diatomaceous silica and lime is described in booklet "Thermobestos Pipe and Block Insulation." Explained is why this completely inorganic insulation has extreme lightness, strength, chemical stability and low conductivity. Included are heat transmission tables. Johns-Manville, 22 E. 40th St., New York 16, N. Y.

Circle No. **39** *on Reply Card*

Oxygen Analyzer

. . . is described in *Bulletin 55-829-56*, which explains the operation and construction of the "Magno Therm Oxygen Recorder." Based on the unusual property of gaseous oxygen, its attraction *into* a magnetic field, the analyzer and integral recorder can be used for the control of catalysis regeneration, flue gas analysis and safety checks on inert gas or explosive mixtures. The Hays Corp., Michigan City, Indiana.

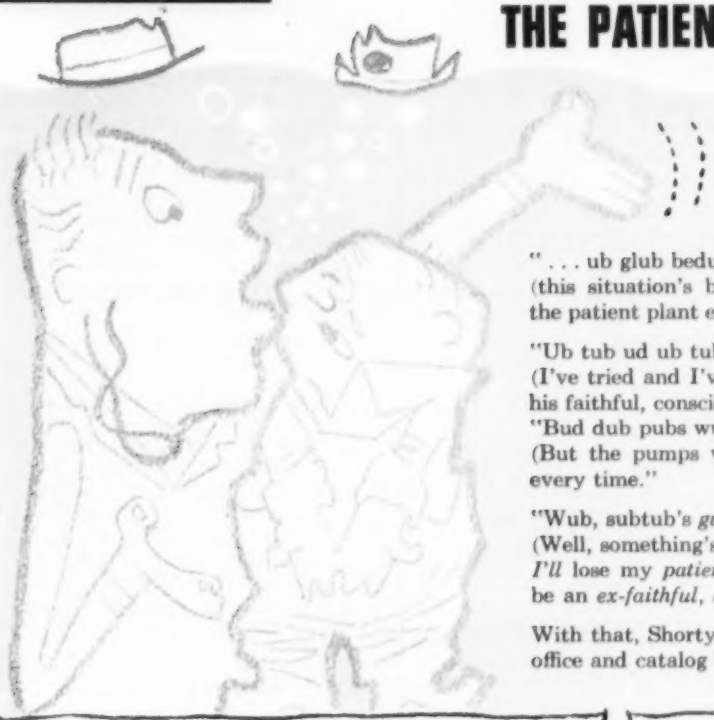
Circle No. **40** *on Reply Card*

Radiation Processing

. . . is explained in *Bulletin E*, a 34-page booklet discussing radiation machines and their application in processing and research. Characteristics of the various forms of radiation, their efficiencies and special applications, and required power output are presented with text and graphs. High

S/Kapades in industry

THE CASE OF THE PERIODIC PUMPING PROBLEM AND THE PATIENT PLANT ENGINEER

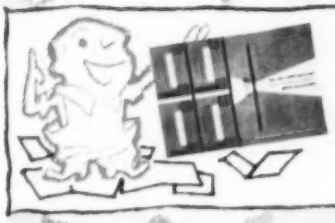


". . . ub glub bedubtub
(this situation's becoming impossible)," glubbled Barney, the patient plant engineer.

"Ub tub ud ub tub ud ub tub
(I've tried and I've tried and I've tried)," bubbled Shorty, his faithful, conscientious assistant,
"Bud dub pubs wud hubtub dub slubb
(But the pumps won't handle the sludge)—it ruins them every time."

"Wub, subtub's *gub* tub bub dub
(Well, something's *got* to be done)," answered Barney. "Or, *I'll* lose my *patience* AND YOU'LL LOSE . . . well, you'll be an *ex-faithful, ex-conscientious* assistant plant engineer."

With that, Shorty stubbled away . . . in the direction of his office and catalog files.

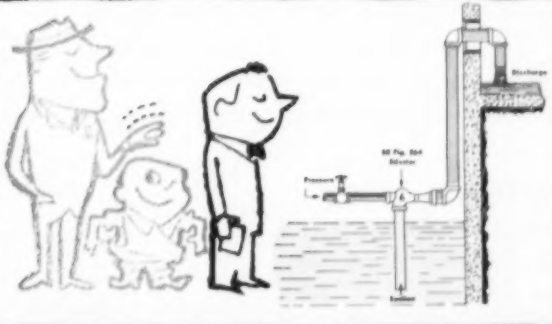


"I've got it," shouted Barney. "It says either an SK Jet Eductor or Syphon is good for pumping liquids where solids or semi-solids must pass through the apparatus and is ideal for use where pumping is periodic."

So he called in his nearest SK Sales Engineer who made an on-the-spot survey of the situation and, because of certain special considerations, recommended the use of an SK Fig. 264 Water Jet Eductor.

PATIENCE REWARDED

It paid to be patient. Now, the recurring drainage problem has been solved, simply and inexpensively. The SK Fig. 264 Water Jet Eductor uses pressure liquid, entering the eductor through a nozzle, to create a vacuum in the line which causes the suction liquid to flow up into the body of the eductor where it is entrained and discharged. Solids and semi-solids present no problem. Since there are no moving parts and the eductor is self-priming, the jet is ready to operate when required.



MORAL:

Get acquainted with all types of SK Jet Apparatus. Send for a copy of Condensed Bulletin J-1. Make use of a qualified specialist, your nearest SK Sales Engineer.

Schutte and Koerting
COMPANY
MANUFACTURING ENGINEERS

2247 STATE ROAD, CORNWELLS HEIGHTS, BUCKS COUNTY, PA.

JET APPARATUS: Ask for Condensed Bulletin J-1.
ROTAMETERS & FLOW INDICATORS: Ask for Condensed Bulletin 58-65.
VALVES: Ask for Condensed Bulletin V-1.
HEAT TRANSFER APPARATUS: Ask for Condensed Bulletin HT-1.
DEAD PISTONS: Ask for Bulletin 17-A.

ARE YOUR FILES UP TO DATE?

Send for these reprints of articles which have appeared in PETROLEUM PROCESSING.

Just circle the proper number on Area "C" of the Reader Service Card, pages 143-144. We will send the reprints right away, and send you a bill.

• **The Heat Exchanger**—covering process and mechanical design, cost estimating factors, types of construction, etc. appearing in this issue. 32 pages—$1.00: Circle **R8**

• **Vaporization Equilibrium Constant and Activity Coefficient Charts**—for conditions up to system critical point. 48 pages—$1.50: Circle **R1**

• **Refinery Instruments, What Makes Them Tick?**—covering flow, level and temperature measurement; controllers, control valves and pneumatic transmission. 40 pages—$1.00: Circle **R2**

• **Catalytic Reforming Survey**—with trends, theory and processes for catalytic reforming and aromatics recovery. 48 pages—$0.75: Circle **R3**

• **Chip•n•File Sheets.** $0.20 each, or any 6 for $1.00. Process Data Sheets (**PDS**'s) are 3-page fold-outs with flow diagram, process description, conditions and economics. Engineering Data Sheets (**EDS**'s) are two pages on special heavy paper to allow repeated handling and use.

PDS No. 1, **Ethylene Oxide** Circle **R4**
PDS No. 2, **Butadiene • Butanes** Circle **R5**
PDS No. 3, **L'Azote Ammonia** Circle **R6**
PDS No. 4, **Ethylene—Kellogg** Circle **R9**
PDS No. 5, **Fluid Coking** Circle **R10**
EDS No. 1, **Pressure Fundamentals** Circle **R7**
EDS No. 2, **Temperature Fundamentals** Circle **R11**

Prices for quantity orders furnished on request.

Voltage Engineering Corp., 7 University Road, Cambridge 38, Mass.

Circle No. **41** *on Reply Card*

Laboratory Glassware

. . . is catalogued in a new 206-page publication, *LP 36*, now available from the manufacturer, Corning Glass Works. Among items listed for the first time are color-coded pipettes, centrifuge tubes with screw caps, precision bore tubing, new fritted filters, and new bell and rectangular jars. Laboratory and Pharmaceutical Sales Dept., Corning Glass Works, Corning, N. Y.

Circle No. **42** *on Reply Card*

Did You Miss These?

The following items, reviewed originally in December, have aroused considerable interest. They are repeated briefly as a service to those who might have missed them the first time they appeared. For details, or literature, please use the regular Reply Card in this issue.

Sand Blasting Tool

. . . **cleans the inside of pipes** by merely passing it through a pipe or tube to remove scale or deposit. There is no need to rotate either the pipe or the tool.

The "Torno-Blast" cleans by whirling the sand, or other abrasive material, under great pressure over a conical diverter that covers a complete 360 degrees. **J. C. Fennelly Co.,** 1485 Bay Shore Blvd., San Francisco, Calif.

Circle No. **43** *on Reply Card*

Valve Actuator

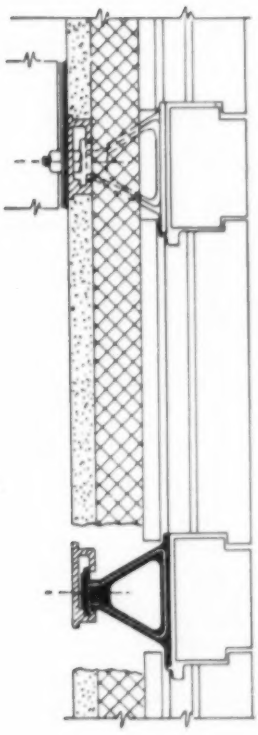
. . . **converts electrical signals** into a hydraulic stroke for operation of a control valve.

This self-contained unit includes control valve, hydraulic power source, and proportional positioning mechanisms that can be used with existing electronic controllers. Outside connections consist of the signal wires from the controller and an electrical power supply.

The signal current is applied to a high-resistance coil (3000 ohms or more) which moves in a magnetic field. Linked to the coil is a patented jet pipe which converts an electrical signal of less than 50 milliwatts into thrusts of 600 lb. or more. The valve moves at a speed of 1 in./sec.; pres-

INTRODUCING
BIGELOW-LIPTAK'S
BI-MET*

Insulated Furnace Walls For High Temperature Applications

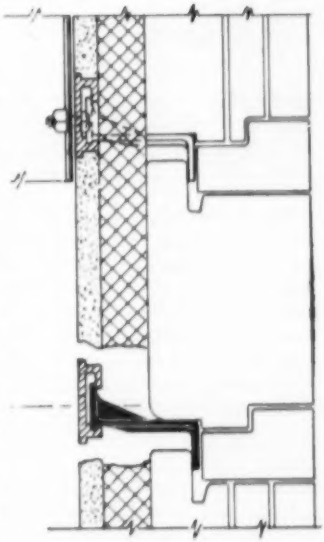


The 4½ inch wall

Here's a job-proven idea which is designed to pare the costs of suspended furnace enclosures. It's used when temperatures are going to be high and when expensive special alloy supporting castings must be used.

Two different castings are used. The first, an alloy clip casting is embedded in the tile where temperatures are highest. This, in turn, is fastened to a standard cast iron support. The design permits the most economical use of costly alloys.

This is a Bigelow-Liptak BI-MET wall and it is another example of B-L's efforts to produce quality furnace enclosures at lower and lower initial costs. Remember: a suspended enclosure for a boiler, a refinery heater, or any other type of installation, will *last longer, have less down time for repairs.* That makes a suspended job the cheapest in the long run. Want to cash in on savings like these? Contact the B-L office nearest you.



The 7 inch wall

*PATENT APPLIED FOR

BIGELOW-LIPTAK *Corporation*

AND BIGELOW-LIPTAK EXPORT CORPORATION
2550 WEST GRAND BOULEVARD, DETROIT 8, MICHIGAN

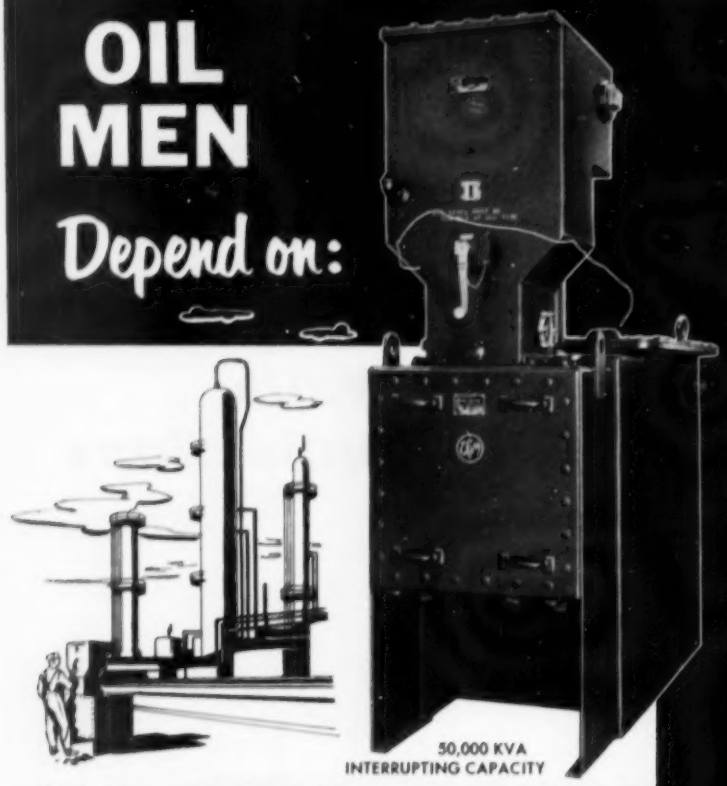
UNIT-SUSPENDED WALLS AND ARCHES

In Canada: BIGELOW-LIPTAK OF CANADA, LTD., *Toronto, Ontario*

ATLANTA • BOSTON • BUFFALO • CHICAGO • CLEVELAND • DENVER • HOUSTON • KANSAS CITY, MO. • LOS ANGELES • MIAMI • MINNEAPOLIS • NEW YORK • PHILADELPHIA • PITTSBURGH • PORTLAND, ORE. • ST. LOUIS • ST. PAUL • SALT LAKE CITY • SAN FRANCISCO • SEATTLE • TULSA • MONTREAL • SAULT STE. MARIE, ONT. • VANCOUVER • WINNIPEG

(To obtain more data on advertised products see page 142)

OIL MEN Depend on:



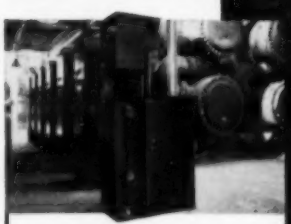
50,000 KVA
INTERRUPTING CAPACITY

EC&M 2200-5000 VOLT Motor Starters

These EC&M Div. 1 combination Starters for Class I, Group D locations give refinery engineers and construction and design companies top value. They require less floor space . . . line, motor and control leads are brought to conduit connection box for quick installation . . . and high interrupting capacity is inherent . . . 50,000 KVA, and no fuses required.

Oil disconnect switch (on top) may be locked open or closed . . . view windows on both sides show switch contacts. Rear oil-tank has potential transformer for 220-volt push button circuit. Type ZHS (50,000 KVA) Magnetic Contactor may be raised above oil for inspection without disconnecting any bolts or leads.

Before buying, investigate EC&M Combination Starters . . . they provide economy in installation, operation and maintenance . . . and they're complete in every respect.



ADVANTAGES of this Battery of EC&M Starters in a refinery.

1. Combination Starter with self-contained Oil Disconnect Switch
2. All internal wiring complete . . . leads brought to conduit box for easy connection to power and motor leads
3. Heavy duty contactor has alloy contacts
4. Slender design reduces floor space
5. Thermal-Magnetic Overload Relays give accurate motor protection . . . trip instantly on faults
6. Simple 3-wire time-delay UVP push button circuit

Write for descriptive Booklet 1062-VIII

THE ELECTRIC CONTROLLER & MFG. CO.

4498 LEE ROAD • CLEVELAND 28, OHIO

ent stroke lengths are up to 2 in. **Askania Regulator Co.,** 240 East Ontario St., Chicago 11, Ill.

Circle No. **44** *on Reply Card*

Mass Flowmeter

. . . **adjusts for variations** in specific gravity from 0.600 to 0.900, and measures flow over a range of 30,000 to 1 or more.

The entire range is covered by five scales. The flow is switched automatically to the proper sensing element when the flow passes above or below the range of the element in operation. Fluid density is constantly measured by means of a detector unit, in which angular rotation proportional to density is produced. An output signal from the detector unit corrects the instrument readings for fluid specific gravity. Accuracy is within ±½% of full-scale for each of the five scales. **Potter Aeronautical Co.,** Route #22, Union, N. J.

Circle No. **45** *on Reply Card*

Solvent Recovery

. . . system using activated carbon is described in 36-page booklet. *Form 4410D* gives technical data on activated carbon, and its applications in the recovery of a wide variety of vaporized solvents. Carbide and Carbon Chemicals Co., 30 East 42nd St., New York 17, N. Y.

Circle No. **46** *on Reply Card*

Heat Loss Graph

. . . eliminates calculations normally required in determining optimum application of mineral wool block and white finishing-cement insulation. Standard thicknesses of block insulation from 1 to 4 inches are plotted for hot-surface temperatures up to 1700° F and for outside surface temperatures up to 220° F. Baldwin-Hill Co., Trenton, N. J.

Circle No. **47** *on Reply Card*

Desiccant Dryers

. . . for air, gases, and liquids: *40-page Bulletin No. D-100* explains the 26 principal variables of dryer design, and the effects temperature and pressure have on the size needed for specific applications. Charts aid in selection of a required dryer. An engineering reference data section presents charts and tables related to desiccants, pressure drop, gas velocity and temperature. C. M. Kemp Manufacturing Co., Baltimore, Md.

Circle No. **48** *on Reply Card*

Your customers want
... from compounded motor oils

Engine cleanliness

Corrosion protection

Performance under all types of operation

Reduced engine wear

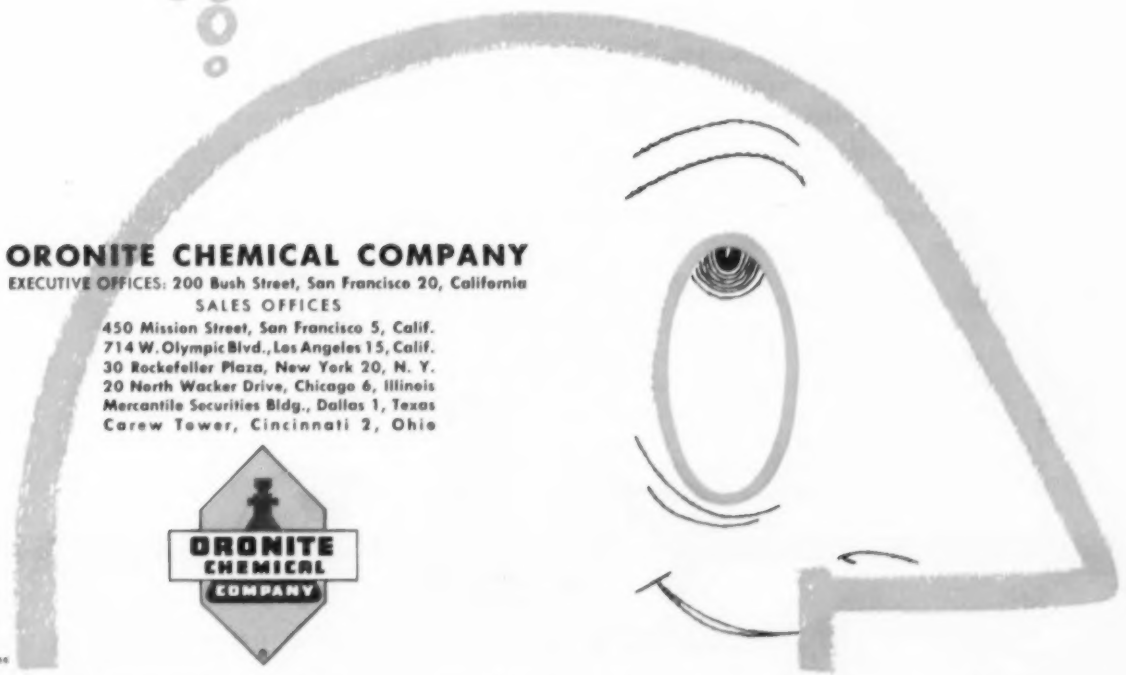
Rust protection

...and Oronite Lube Oil Additives provide these qualities!

Engine cleanliness! The modern automobile demands better motor oils and your customers are well aware of this fact. Throughout the nation, marketers of Oronite additive compounded motor oils are gaining better sales positions with superior products they market. With Oronite additives you can prove "engine cleanliness" and engine protection to your customers.

Custom-formulation to an individual oil marketer's needs is an Oronite specialty. By tailoring to your base oil and individual needs, you can provide your customers with exclusive, made-to-order motor oils.

Why not talk it over with a lube oil additive specialist. Contact the Oronite office nearest you.



ORONITE CHEMICAL COMPANY

EXECUTIVE OFFICES: 200 Bush Street, San Francisco 20, California

SALES OFFICES

450 Mission Street, San Francisco 5, Calif.
714 W. Olympic Blvd., Los Angeles 15, Calif.
30 Rockefeller Plaza, New York 20, N. Y.
20 North Wacker Drive, Chicago 6, Illinois
Mercantile Securities Bldg., Dallas 1, Texas
Carew Tower, Cincinnati 2, Ohio

ORONITE CHEMICAL COMPANY

The Year Advertising Helped

IN 1954 we had a business recession in the United States. Sales fell about 4% during the year. If management had followed the historic pattern of business ups and downs, advertising volume would have fallen much further.

But in 1954 the volume of advertising did not fall. It increased over 5%. Every effort was made to stimulate sales when sales were needed to sustain prosperity.

This was something entirely new under the sun. It had a powerful influence in making the recession of 1953-54 one of the mildest on record. It helped greatly to speed business on to the record-breaking levels it has attained today.

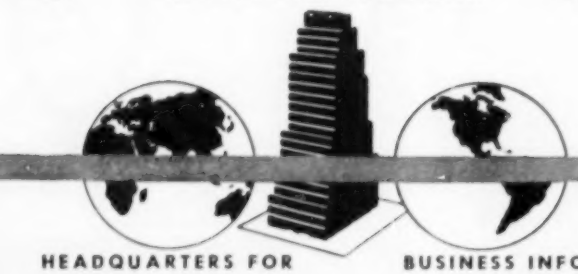
There are several reasons why America's business management attacked this decline in sales with more advertising. One of them grew out of the greatly strengthened position of the American consuming market. Consumers' income after taxes has been rising an average of over $10 billion a year since 1946, and this rising income is more widely distributed than ever before. Furthermore, consumers have piled up reserves of about $215 billion in cash or its equivalent. These reserves offer a new and powerful inducement to increased selling and advertising effort even in the face of a possible decline in consumer income.

Taking the Longer View

However, the principal reason why a sales decline was attacked with increased advertising is management's new-found conviction that good advertising is essentially an investment in the development of a market. Successful development requires sustained investment. The inclination of business management to take this longer view, is, of course, motivated by the fact that the American market, with over 3 million consumers being added annually, is growing at a prodigious rate.

Ten years ago only a handful of companies had plans for investment in new producing facilities extending beyond the current year. Today almost all leading companies have investment programs running some years ahead. And keeping pace with these long-range business investment plans has been the development of sales and advertising programs to

McGraw-Hill
PUBLISHING COMPANY, INC.
330 West 42nd Street, New York 36, N. Y.



HEADQUARTERS FOR BUSINESS INFORMATION

Kill a Business Recession

reach tomorrow's greatly expanded markets.

This crucial role of advertising in providing driving power for our economy is gaining greater recognition every day. In his recent book, "People of Plenty," Professor David M. Potter of Yale University remarked: "Advertising is not badly needed in an economy of scarcity, because total demand is usually equal to or in excess of total supply, and every producer can normally sell as much as he produces. It is when potential supply outstrips demand—that is, when abundance prevails—that advertising begins to fulfill a really essential economic function."

Advertising's Key Role

Today abundance so completely prevails in the United States that it has been conservatively estimated that as much as a third of everything offered for sale falls in the realm of "optional consumption." That is, consumers can "take it or leave it" without any immediate personal inconvenience. But if they decide to "leave it," a terrific economic depression will not be far behind. In such circumstances, advertising—in which, in all of its forms, we are now investing about $9.2 billion annually—clearly is of crucial importance to our continued prosperity.

In performing its key role in past years, American advertising never realized its full potential. It successfully promoted sales. But it never was called upon to promote an overall economic stability as a direct outgrowth of increased sales.

By successfully promoting both sales and economic stability, as it did in 1954, advertising surely has added new strength to the American economy. It has also added a great new and constructive dimension to advertising itself. This accomplishment gave great significance to the celebration of the first National Advertising Week in February, 1956.

One of the surest means of expanding your sales volume in today's $150 billion *industrial* market is through dominant advertising in the publications directly serving your major customers and prospects.

McGraw-Hill's business and technical publications can give you quick access to the men who initiate, specify and approve the purchases of industrial products and services. Because all are leaders in their respective fields, you are assured a maximum return on your investment when you specify a McGraw-Hill publication to carry your advertising to your most important markets.

EDITORIALS . . .

"Blended-at-the-Pump" Gasoline

SUN OIL CO. has begun testing a new way of blending motor gasoline at the service station. The system involves a special pump, built by Wayne Pump Co. to Sun's own specifications. This pump draws a regular-grade gasoline from one underground tank and a special "octane concentrate" from another—proportioning and blending the two according to a pre-selected ratio to deliver any one of five grades of gasoline. The lowest grade is Sun's regular Blue-Sunoco (about 93 octane, according to one recent survey); the highest is said to rate over 100 octane.

Sun's move is based on the wide spread in octane requirements of different cars. Frank R. Markley, Sun's marketing vice-president, states: 'Even among the 1956 automobiles there is a spread of at least 10 octane numbers between the needs of the lowest- and highest-compression engines." Sun believes it should meet the higher requirements of today's engines—but at the same time relieve the owner of an older car from paying for more quality than he needs.

The octane concentrate is described by Sun as "a mixture of a small number of specially selected hydrocarbons, blended with stocks from a Sun-developed process, and combined with tetraethyl lead." Presumably it is high in aromatics, since Sun has considerable catalytic reforming capacity, as well as facilities for extracting selected aromatics.

So far, this novel marketing scheme is being tested in only the Orlando, Fla., area. And admittedly it is aimed primarily at attracting more gasoline business to Sun's stations.

But refiners should be asking themselves two questions if this "blending-at-the-pump" proves successful and is adopted on a wide basis:

One deals with the effect this type of operation would have on blending at the refinery. We think it will probably not reduce a refiner's blending activities, but will simplify them. Instead of blending different qualities of gasolines for different marketing areas (Sun's Blue Sunoco may vary from 92.7 in Florida to 94.3 in New York, the refiner would have to blend only one grade of gasoline and one concentrate. The marketer would suit his local needs by varying the proportion of each he used. An indirect benefit might be to loosen up storage at the refinery.

A second question has to do with the problem of fuels for the gas turbine automobile of the future—and we're assuming there will be both such an automobile and such a problem. Here we think Sun's scheme may possibly hold the solution. If the regular-grade used for blending purposes is a clear fuel of comparatively low octane rating, it could be used alone for gas turbine engines. And the higher octane grades for reciprocating engines could be blended by increasing the amount of concentrate used.

Maybe we're just dreaming, but at least they are interesting dreams—not nightmares. And we admire Sun or its unusual approach to an old problem—tailoring gasoline to meet your customers' needs.

A Dime a Day for Corrosion

LAST month a group of 2,000 engineers, chemists and metallurgists assembled in New York to exchange ideas on a really hot topic—corrosion. They got together for the annual conference of the National Assn. of Corrosion Engineers.

We don't want to detail here how much corrosion costs the petroleum industry—except to remind you that one pretty reliable estimate puts it at over $220-million a year for refineries alone.

But we were struck by one figure that came out of the meeting.. It was estimated country-wide that corrosion eats up over $6-billion annually in direct costs for protection and replacement.

That figure means that every person in the U.S. each year pays about $35 more for goods and services, hidden in their costs, because of corrosion. Look at it another way and you can say that every day you have to throw a dime into the gutter.

That's bringing it pretty close to home—even if those are thin dimes being tossed away.

Come, Senator—Look More Closely

SENATOR ALLOTT (a Republican from Colorado) appeared before a Senate Appropriations subcommittee last month and charged that the oil companies have failed to show progress in perfecting methods for commercial production of oil from shale.

He was arguing for putting back into the Federal Budget funds to me used for shale-oil studies by the Bureau of Mines at Rifle, Colo., and Laramie, Wyo.

We'd like to remind the Senator of only two facts:

1—The Bureau of Mines since 1945 has already spent many tens of millions of dollars on shale oil studies—and hasn't yet come up with commercially-practical methods of making liquid fuels from the stuff.

2—Union Oil Co. of California last year allotted $5-million for a pilot program aimed at commercial shale-oil operations, and has let the engineering contract for a 1,000 ton/day shale retort.

Of course, we realize that Colorado has a lot of shale, and that Senator Allott has the interests of his constituents at heart. But wouldn't it be nice if the politicians would be a little bit less selfish, and think about the taxpayers in the other 47 states.

Information! How to Purchase and use RADIOCHEMICALS

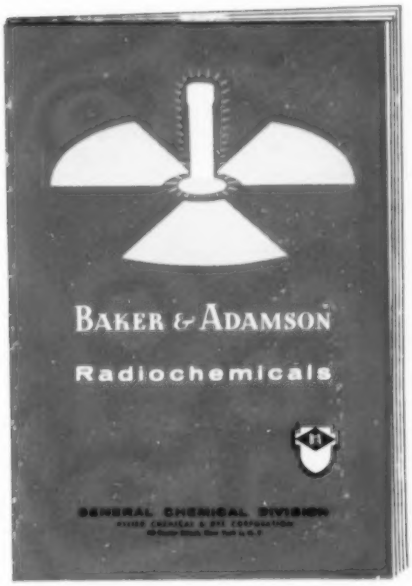
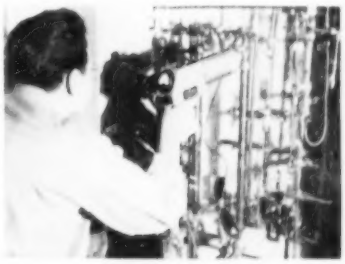


Illustration from catalog showing use of radioactive piston ring to study engine wear (Standard Oil (N J.) Photo)



The ready detectability of radiochemicals makes them extremely valuable for analytical purposes.

A minimum of special facilities is adequate to establish a program using radioisotope reagents.

Industrial and research applications of radioisotope reagents are increasing by leaps and bounds. Virtually every field can use them profitably. That's why Baker & Adamson's special 24-page radiochemicals catalog is a "must" for everyone who wants to learn more about these unique new nuclear tools.

The booklet is simple, clear, instructive; written for the non-technical management man as well as the laboratory scientist. Besides telling what radiochemicals are, it includes:

- Information on the most important fields of use.
- Complete listings of the full line of B&A Radiochemicals including Carbon-14 Labelled Compounds and Deuterated Compounds as made for B&A by Tracerlab, Inc.
- Formulae, specific activities, energy in MEV of principal radiations.
- Data on prices, packaging, shipping and handling.
- Details on how to obtain necessary AEC authorization.

GET YOUR FREE COPY! Fill in coupon or write today on your letterhead for a copy of Baker & Adamson Radiochemicals and learn how you too may benefit from using them in your research and development programs.

BAKER & ADAMSON *Reagents*

GENERAL CHEMICAL DIVISION
ALLIED CHEMICAL & DYE CORPORATION
40 Rector Street, New York 6, N. Y.

ATTACH TO YOUR LETTERHEAD AND MAIL.

BAKER & ADAMSON PRODUCTS
GENERAL CHEMICAL DIVISION
ALLIED CHEMICAL & DYE CORPORATION
40 Rector Street, New York 6, N. Y.

Please send a copy of catalog "Baker & Adamson Radiochemicals"

Name _____

Position _____

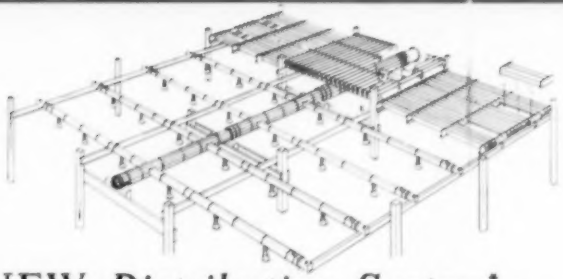
Company _____

Address _____

City _____ Zone _____ State _____

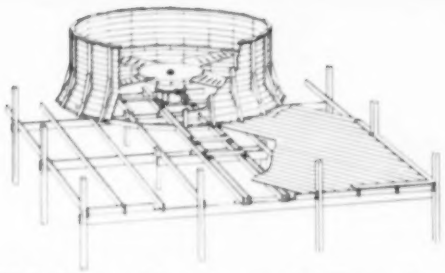
FP-4

The new IMPROVED *Fluor "FPA" Cooling Tower your best* DESIGN *buy because...*



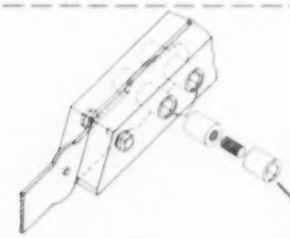
NEW *Distributing System**

Completely non-corrosive . . . header and laterals of redwood stave construction banded with stainless steel . . . nozzles of porcelain and stainless steel. All headers and laterals are provided with cleanout valves and plugs for flushing during tower operation.



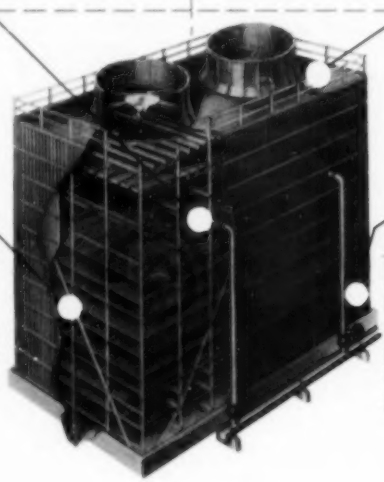
NEW *Fan Deck and Stack*

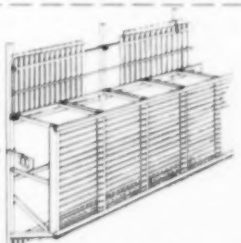
Diagonal decking, blocking and stress strips form a *structural diaphragm* which distributes live loads – wind, vibration – uniformly to *all* bracing. New stack has stress strip around entire periphery.



NEW *Joint Connectors**

Unique round-headed socket nuts present a greater bearing surface to the wood than does bolt shank . . . allowable value per connector is increased. This together with the heavier gusset plate design, effectively multiplies each joint's allowable load.





NEW *Offset Louvers...*

Set three feet out from side, yet require no greater basin dimensions. Air is drawn into tower with less pressure drop. Improvement in winter operation . . . icing problem formerly associated with louvers adjacent to tower columns eliminated.

**Patent applied for.*

The new *improved* Fluor Model "FPA" Induced Draft Cooling Tower is an ideal balance between standardized construction and a tailor-made tower. It reflects Fluor Products' concerted effort – in the face of rising costs – to maintain and *improve* quality for lowest "first" cost. It retains the time-proven design features of previous models of Fluor Induced Draft Counterflow Towers . . . plus *new* design features that deliver maximum service and performance from all components. For optimum cooling capacity per square foot of ground area . . . for a combination of the best in structural design and quality-proven mechanical equipment at the most favorable price . . . and for new design features which ensure year-in, year-out, trouble-free service, look first at Fluor's "FPA" Tower – your *"best design buy"* in cooling towers. Inquiries for details are invited.

MANUFACTURERS AND FABRICATORS OF COOLING TOWERS, PULSATION DAMPENERS, MUFFLERS, PREFABRICATED PIPING AND OTHER WOOD AND METAL PRODUCTS.

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